This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

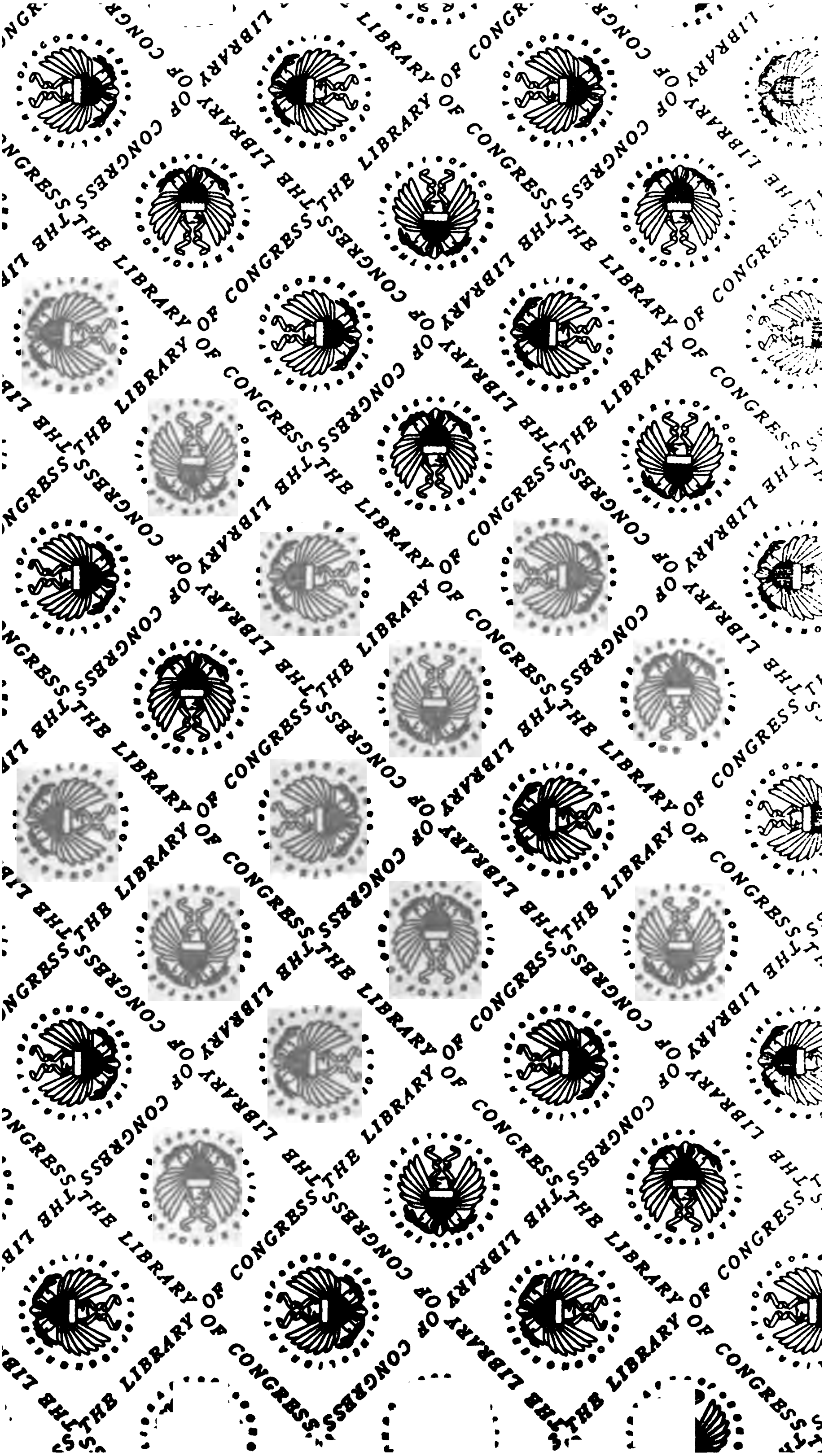
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

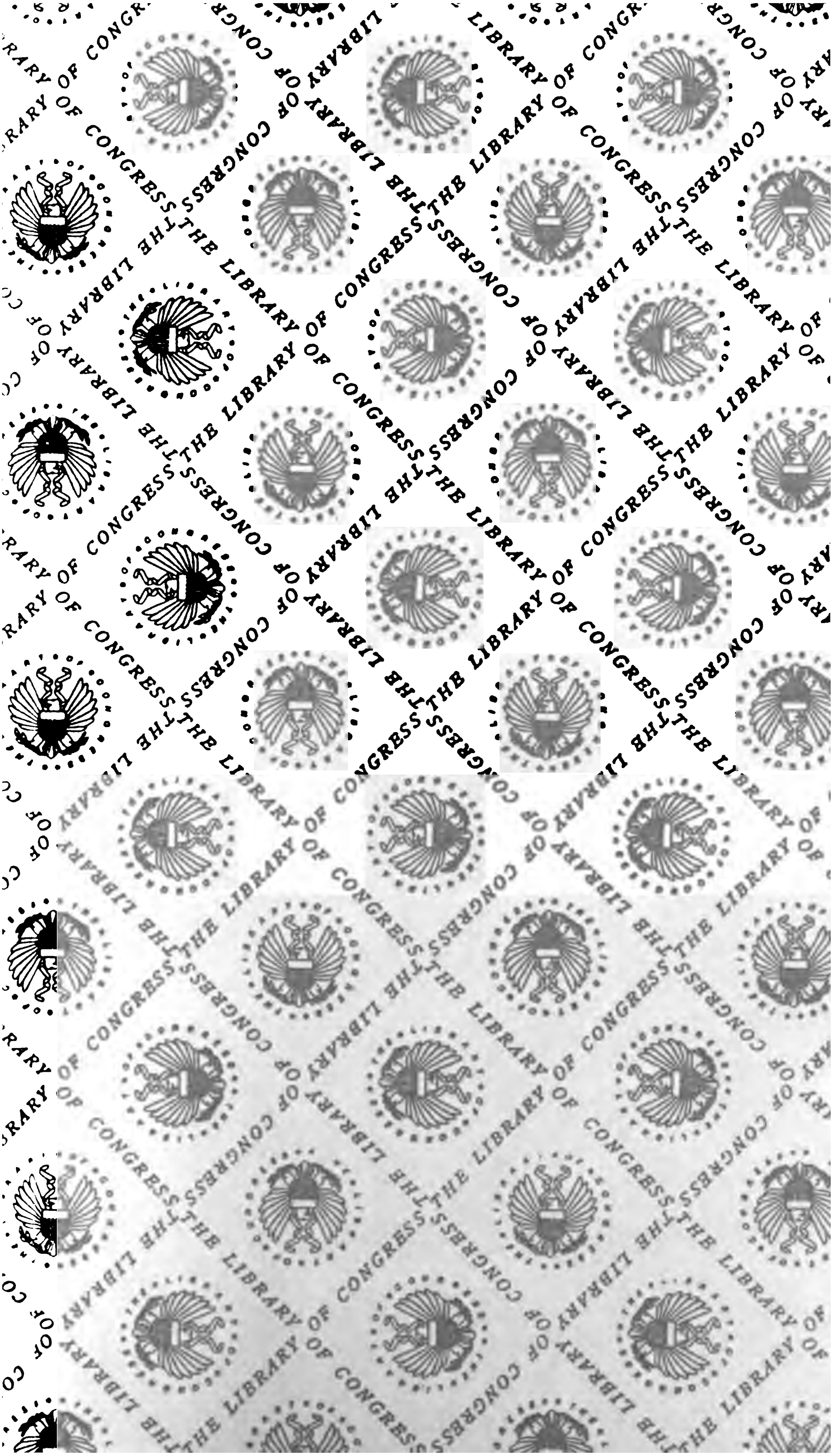
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`


THE LIBRARY OF CONGRESS


THE LIBRARY OF CONGRESS

Published monthly by the
New York State Education Department
BULLETIN 408 JULY 1907

New York State Museum

JOHN M. CLARKE, Director

Bulletin 111

GEOLOGY 13

DRUMLINS OF CENTRAL WESTERN NEW YORK

BY

H. L. FAIRCHILD

PAGE
Introduction: general description 391
Areal distribution 391
Orientation 399
Relation to larger topography 402
Relation to underlying rock strata 404
Form and dimensions 405
  Dimensions 410
Composition and structure 412
  Rocdrumlins 413
  Concentric bedding 416
Formation: theoretical mechanics 419
  a Dynamic factors pertaining to the ice body 420
  b Factors relating to the drift held in the ice 421
  c Factors of external control 422
  Drumlin forms and observed relations 422
Relation to moraines 424
Special features 425
  Syracuse island masses 425
  Montezuma island groups 426
  Nondrumlin areas: open spaces 426
  Channels among the drumlins 427
Summary 429
  Age of the drumlins 429
  Thrust motion of the ground contact ice 429
  Origin 431
  Dynamics 432
  Drumlin forms 433
  Depth of the drumlin making ice 434
Drumlins of Ireland 435
Bibliography 436
Index 441

ALBANY
NEW YORK STATE EDUCATION DEPARTMENT
1907

M169m O6-1000

Price 35 cen

Collected set.

Q11
N82

STATE OF NEW YORK
EDUCATION DEPARTMENT

Regents of the University

With years when terms expire

1913	WHITELAW REID M.A. LL.D. *Chancellor*	New York
1917	ST CLAIR MCKELWAY M.A. LL.D. *Vice Chancellor*	Brooklyn
1908	DANIEL BEACH Ph.D. LL.D.	Watkins
1914	PLINY T. SEXTON LL.B. LL.D.	Palmyra
1912	T. GUILFORD SMITH M.A. C.E. LL.D.	Buffalo
1918	WILLIAM NOTTINGHAM M.A. Ph.D. LL.D.	Syracuse
1910	CHARLES A. GARDINER Ph.D. L.H.D. LL.D. D.C.L.	New York
1915	ALBERT VANDER VEER M.D. M.A. Ph.D. LL.D.	Albany
1911	EDWARD LAUTERBACH M.A. LL.D.	New York
1909	EUGENE A. PHILBIN LL.B. LL.D.	New York
1916	LUCIAN L. SHEDDEN LL.B.	Plattsburg

Commissioner of Education

ANDREW S. DRAPER LL.B. LL.D.

Assistant Commissioners

HOWARD J. ROGERS M.A. LL.D. *First Assistant*
EDWARD J. GOODWIN Lit.D. L.H.D. *Second Assistant*
AUGUSTUS S. DOWNING M.A. Pd.D. LL.D. *Third Assistant*

Secretary to the Commissioner

HARLAN H. HORNER B.A.

Director of State Library

EDWIN H. ANDERSON M.A.

Director of Science and State Museum

JOHN M. CLARKE Ph.D. LL.D.

Chiefs of Divisions

Accounts, WILLIAM MASON
Attendance, JAMES D. SULLIVAN
Educational Extension, WILLIAM R. EASTMAN M.A. M.L.S.
Examinations, CHARLES F. WHEELOCK B.S. LL.D.
Inspections, FRANK H. WOOD M.A.
Law, THOMAS E. FINEGAN M.A.
School Libraries, CHARLES E. FITCH L.H.D.
Statistics, HIRAM C. CASE
Visual Instruction, DELANCEY M. ELLIS

New York State Education Department
Science Division, October 19, 1906

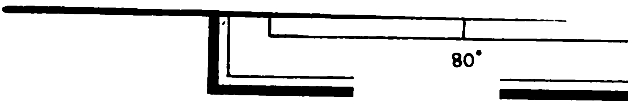
Hon. Andrew S. Draper LL.D.
Commissioner of Education

SIR: I communicate herewith, for publication as a bulletin of the State Museum, an important paper on the glacial phenomena of New York, entitled the *Drumlins of Central Western New York* by Professor H. L. Fairchild.

Very respectfully yours
JOHN M. CLARKE
Director and State Geologist

Approved for publication October 20, 1906

A. S. Draper
Commissioner of Education


80°

New York State Education Department

New York State Museum

John M. Clarke, Director

Bulletin 111

GEOLOGY 13

DRUMLINS OF CENTRAL WESTERN NEW YORK

BY

H. L. FAIRCHILD

Introduction: general description

Among the varied products of glacial work the smooth mounds and ridges known as drumlins are the most singular. They are the product of continental glaciers by the unique rubbing or molding action of the latter as plastic solids. In their form, attitude, composition and relation they are not only the most remarkable and interesting of the glacial drift deposits but in their graceful outlines and smooth surfaces they are the most striking and beautiful of drift forms, if not of all topographic forms of moderate size. Long before the glacial origin of the drift was established these smooth-outlined hills had attracted attention. They were cited as an objection to the theory of continental glaciation because they seemed inconsistent with the supposed planing and leveling effect of the ice sheet; and even up to the present time they have remained something of a difficulty if not a puzzle. Although the subglacial origin of the drumlins is generally admitted and their constructional genesis conceded, at least in part, the precise mechanical operation in their upbuilding by the antagonistic and balancing forces has not been analyzed. Some of the factors in this complicated problem in glacial mechanics will be indicated below.

The State of New York may claim with confidence the possession of the most remarkable group of drumlins in the world, when all the facts relating to them are taken into account. This drumlin area has been under the writer's observation for several years and the results of the study will help, it is thought, to elucidate the problem of drumlin formation. It is recognized that no single drumlin area may exemplify all the features belonging to these drift forms, but the New York area includes such a large variety of forms and relationships that it should illustrate the fundamental mechanics and most of the phenomena.

For the reader who may not be familiar with this form of the glacial drift a brief description of its general character will be appropriate. That these hills are of glacial origin is evident from their location always within the glaciated territory, their superficial position and their composition which is compact till or ground moraine, at least in New York. Their molded forms show the over-riding effect of the ice and they are believed to have been shaped, if not constructed, under the relatively thin and weaker border of the continental ice sheet, along the zone where the ice in its transporting power became incompetent to carry further its drift burden. Their forms vary from mounds to long, slender ridges; and their size from massive, conspicuous hills, 100 or 200 feet high, to indefinite swells of the drift surface.

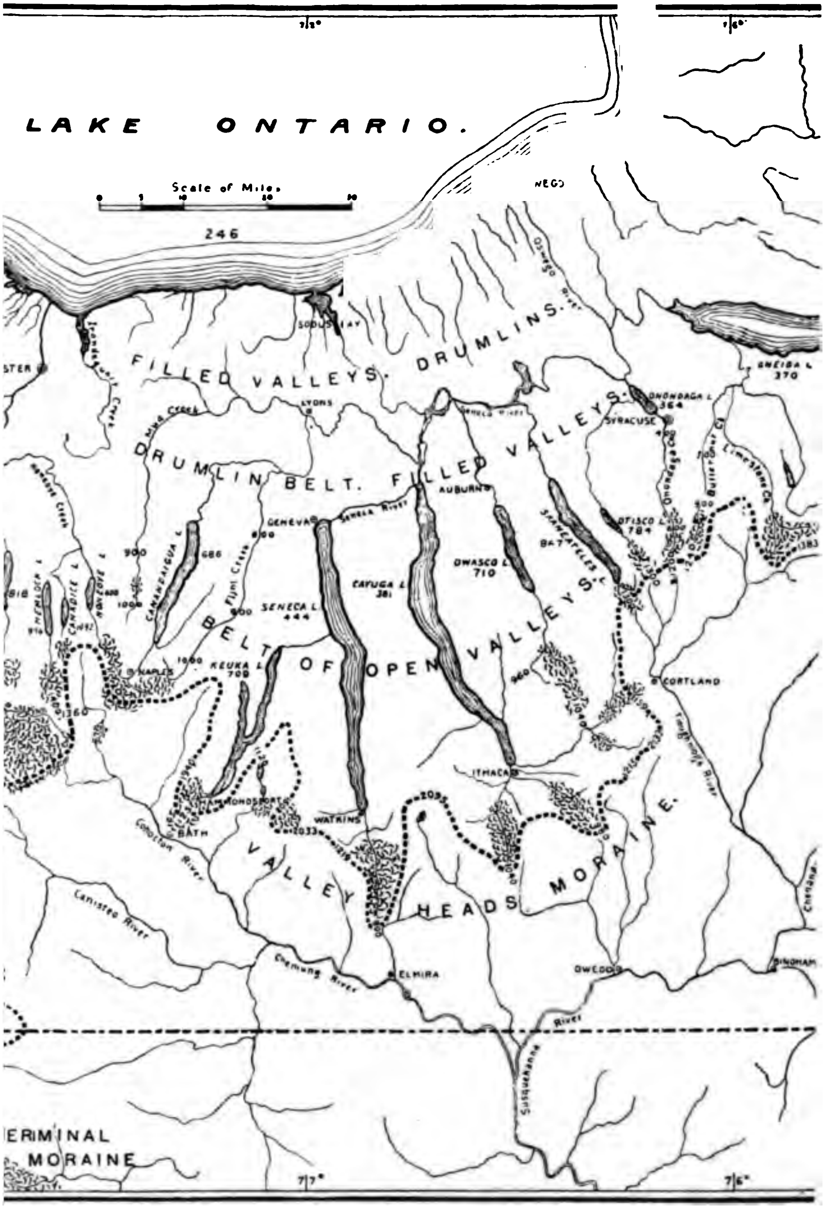
The history of the earlier study of drumlins may be read in the article by W. M. Davis, "Distribution and Origin of Drumlins" [*see* p. 437]; and also in the papers by Warren Upham, specially those of the years 1889, 1892 and 1893 [*see* p. 438]. A brief synopsis of the description by Kinahan and Close of the type drumlins in Ireland is appended as pages 435–36, with a copy of part of their map [pl. 47].

The following names were formerly applied to the drumlin forms: parallel ridges, Sir James Hall, 1815; drumlins, H. M. Close, 1866; parallel ridges, Shaler, 1870; lenticular hills, Hitchcock, 1876; whalebacks, Matthew, 1877; drums and sowbacks, J. Geikie, 1877; parallel drift hills, Johnson, 1882; mammillary and elliptical hills, Chamberlin, 1883.

The name "drumlin" (derived from the Celtic and meaning "little hill") was first applied by H. M. Close in 1866 to these drift hills in Ireland. The various names formerly applied have by common consent given way to the present name, which was introduced in this country by W. M. Davis in 1884

Drumlins are so diverse in their form, and possibly in their precise origin, that any terse definition must be somewhat vague. The smooth form, convex profile and parallelism with the ice flow

Plate 2

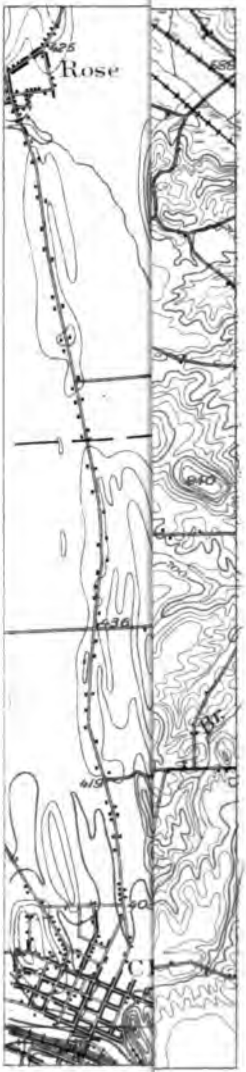


PHYSIOGRAPHIC BELTS IN CENTRAL NEW YORK

ATE OF NEW YOR

JSEUM

TIN 111 PLATE 3



N TOPOGRAP

H.L.Fairchild 1905

direction are the striking superficial characters; but along with these elements the composition and subglacial origin must be recognized. Omitting reference to the precise manner of their amassing, they may be defined as smooth-surfaced hills of till, elongated in the direction of ice movement by the rubbing action of the ice sheet. Or, more briefly, they may be defined as smooth drift hills shaped by ice molding.

The topographic expression of drumlins is so emphatic that any group with fairly developed forms is readily distinguished on maps in 20 foot contours. Plate 3 affords a comparison of drumlinized drift with other forms of glaciated topography.

It appears that the molding effect of the overriding ice was not restricted to the drift masses deposited during the rubbing process by the ice itself, but was felt by moraines or even by rock masses which were exposed to the ice rubbing. The latter effect is seen specially along the summits of the rock ridges that were buried under the glacier [*see* pl. 10]. The name drumlin can not appropriately be applied to ice-shaped rock masses, though the relationship to drumlins may be evident. The term "drumloid" is fully appropriate but the word has long been used in a rather loose and indefinite way for hills of drift having merely a formal and perhaps accidental resemblance to drumlins. A distinctive term with obvious meaning is desirable, and it is proposed to call these forms *Rocdrumlins*, using as a prefix the Celtic word for rock. In the case of ice-worn hills or summits of rock which suggest the drumlin form but do not fully attain it we may use the term *rocdrumloid.*

It should be emphasized that rocdrumlins are an effect of a moderate amount of erosion, or the removal of material, while the drumlins are a product of upbuilding and shaping at the same time [*see* p. 432] The genetic distinction is important.

It seems probable that hill summits of rock should receive under favorable conditions a drumloid expression, that is, a roches moutonné form on a large scale. Plate 16 shows quite as good an example as the published topographic sheets of western New York supply, and even this is somewhat equivocal. Eastern New York can probably furnish better examples. However, it may be said that the erosional work of the continental ice sheet was commonly insufficient, at least in western New York, to strongly mold the hilltops. The absence of such effect is seen in plate 3, figure 1.

Areal distribution

Drumlins have an irregular and apparently capricious distributi over the glaciated territory of Europe and America and over la areas seem to be entirely wanting. None have been reported fr Ohio, Indiana, Illinois, Minnesota, the Dakotas, southern Michig and most of Iowa. They are at least very rare in Pennsylvania a New Jersey. In Maine they are not infrequent but are inferior numbers and size to those found southwestward.

There seem to be three regions of great drumlin development the United States. The New England area includes southern N Hampshire, where Upham has mapped nearly 700 drumlins ; Mas chusetts with 1800, as described by Barton ; and a southw extension of the area across Connecticut. The Michigan a includes the eastern part of Wisconsin and adjacent territory Michigan, where Chamberlin estimates that there are 5000 drumlin also east of the north end of Lake Michigan in the Grand Trave district. The third area is the subject of this paper.

Drumlins have been noted in the southern part of Canada G. F. Matthew, in Manitoba and Athabasca by J. B. Tyrrell, and said to occur in Nova Scotia.

The drumlins of Ireland are the type forms and are briefly descri at the close of this paper [p. 435–36]. Drumlins also occur the Clyde valley in Scotland, and in the Lake Country of Engla as described by Upham [titles for 1898, p. 439]. In the low grou of Switzerland they are said to occur ; also in northern Germany the island of Rügen and east of the lower part of the river Od Dr Keilhack has described in the latter area a group of 3 drumlins.[1] They are said to be disposed radially, facing a loo marginal moraine, covering a belt 6 by 20 to 40 miles.

In Scandinavia drumlins have escaped notice, unless certain c ridges in Sweden, noted by James Geikie,[2] represent drumlini surface.

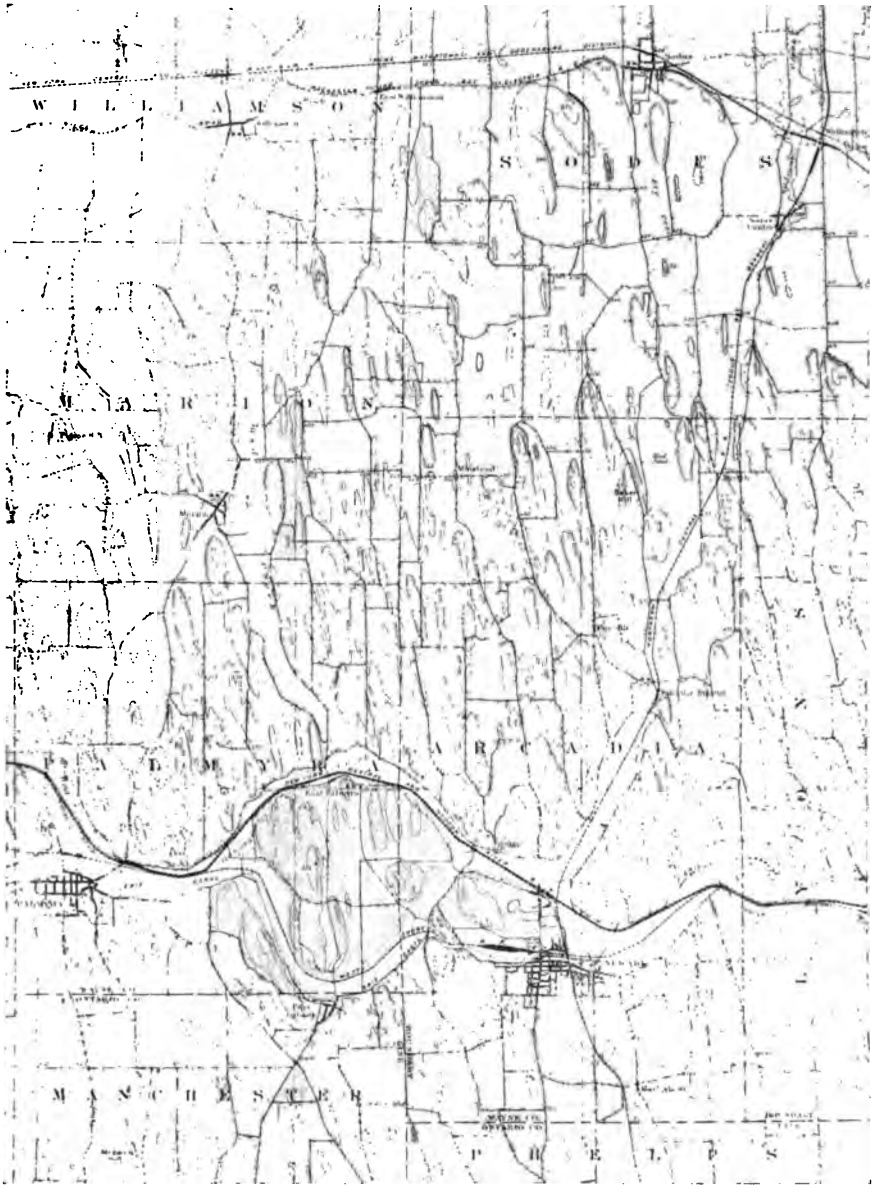
When it is recognized that typical drumlin or drumlin ridges only the most emphatic of a variety of forms produced by the r bing of ground-contact ice under thrust motion [*see* p. 429], a that on the one hand these forms shade off into indefinite flutings

---

[1] Keilhack, K. Jahrbuch K. Preuss. geol. Landesanstalt. 1896. p. 163–88.

[2] Earth Sculpture. 1898. p. 234.

Plate 4



Palmyra quadrangle. Drumlins on the Sodus-Newark meridian. The south edge of the belt lies on the Phelps quadrangle.

moldings of the drift, and on the other hand are represented by scoured or rounded roche-moutonnéed rock hills (rocdrumlins), it is probable that this class of phenomena will be found somewhat more widely distributed in the glacial areas than has been supposed. However, the requisite conditions for production of typical drumlins do not seem to have been commonly fulfilled, as vast areas of the glaciated territory seem never to have been subjected to the drumlinizing movement of the ground-contact ice.

The land surface included in the great drumlin area of New York is a belt about 35 miles wide, bordering the south side of Lake Ontario, and about 140 miles long (from Niagara river to Syracuse), with a total area of about 5000 square miles. At least half of this area, or 2500 square miles, carries numerous and well developed drumlins. The eastward extension of the drumlin area swings around the east end of Lake Ontario as a belt 5 to 10 miles wide, reaching past Watertown into the St Lawrence valley. An area in Chautauqua county can not be estimated as the region is not topographically mapped, but the drumlins are scattering.

The New York drumlin area probably includes not less than 10,000 drumlin crests, of which on a conservative estimate at least 6000 are indicated on the topographic sheets. In the districts where the drumlins are close set from 20 to 35 can be counted in a square of 4 square miles. Five drumlins to the square mile is common. Three to the mile can not be more than the average, counting large and small, and on the 2500 square miles of well developed drumlin topography this would give 7500 drumlins. Estimates have been made by counting the separate drumlin summits or crests indicated by the contour lines in certain limited districts and using the figures for larger areas, with a result giving about 5000 crests for the 15 topographic sheets that cover the best parts of the drumlin area. On the 216 square miles of the Palmyra quadrangle [pl. 4] the estimated number of drumlin crests was 800, while an actual count gave 955. Hundreds of minor ridges are beneath the recognition of the contour lines.

The area of well developed drumlins extends eastward around the east end of Lake Ontario, where they are specially interesting on account of their attitude and peculiar form [pl. 5], and reaches westward as far as the meridian of Batavia. The Pulaski, Sacketts Harbor and Watertown sheets show the northeastward ending of the Ontario drumlin area, while the lower half of the Brockport, Albion and Medina sheets show the westward termination as far as the drumlin forms are indicated by the map contours [pl. 17]. West of the Genesee river and near the Ontario shore distinct drumlins occur, shown in plate 18, where the Iroquois waters were too deep for effective erosion. Westward, on the Niagara-Genesee prairie, the drumlin forms gradually become very elongated and indefinite low ridges, which slowly change to faint, invisible swells dying out farther west. On the sheets toward Niagara the drumlinized character of the surface is suggested only by the obliqueness of the streams and contours to the general slope [pl. 19].

Southeastward the drumlin area terminates in peculiar fashion; forming a decided point at Syracuse. The most easterly drumlins are the conspicuous group southeast of the city of Syracuse, which stand on a base of Salina shales. The map shows no well formed drumlins north of Syracuse, over the Oneida lake depression, nor on the high ground south of the Syracuse district. This extension of strong drumlins as a tongue or point into a district otherwise destitute of such forms is a striking and important fact.

East of Syracuse, as at Fayetteville, Canastota and Oneida, the soft Salina shales which compose the irregular ground surface show no effect of ice rubbing and carry only just enough drift to prove the former presence of the ice sheet. The topography is easily mistaken for morainal, but is due to atmospheric erosion.

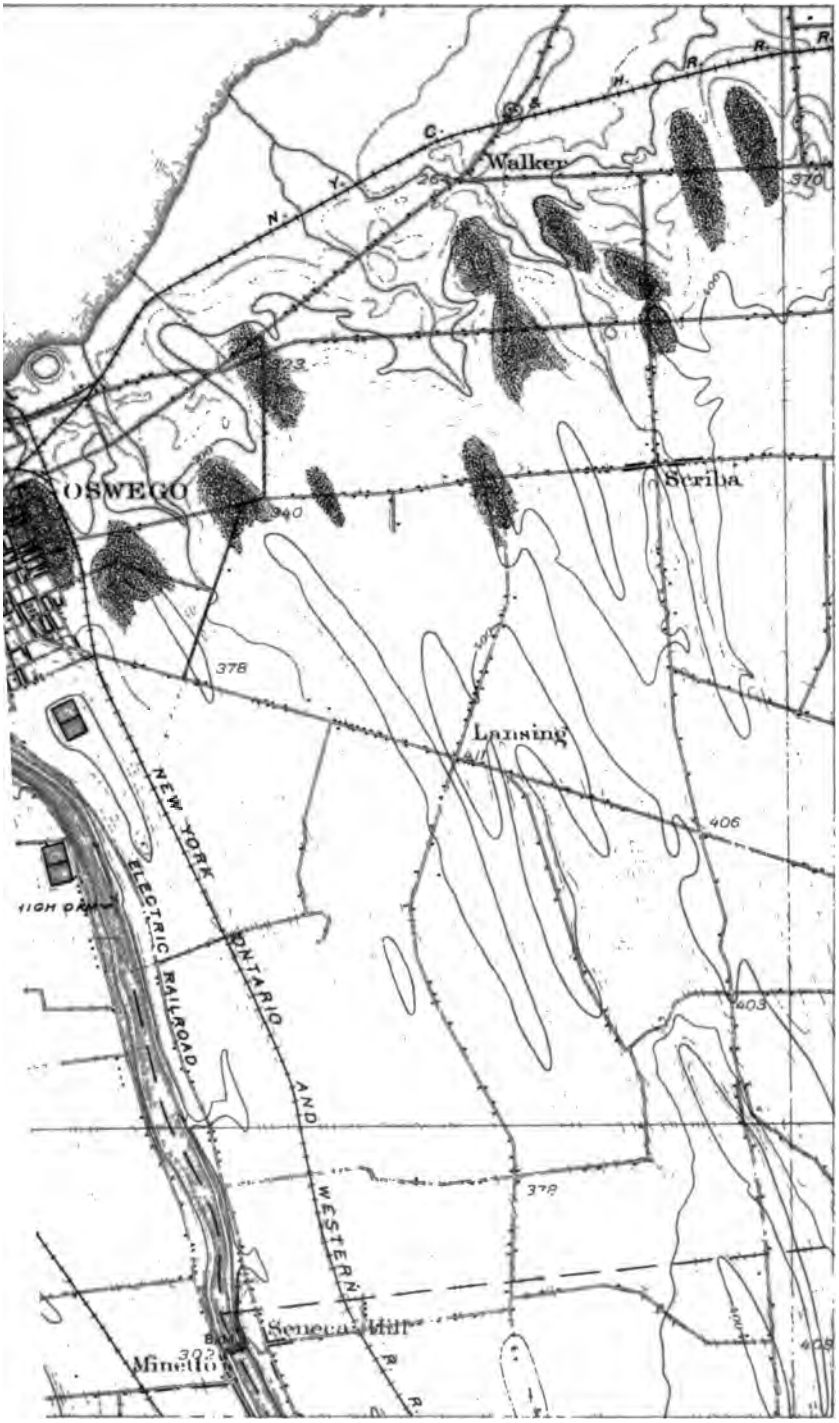
Plates 5 to 21 show some groups of drumlins, interesting for either attitude or form, arranged somewhat in geographic order from east to west. The Weedsport [pl. 11], Clyde and Palmyra [pl. 4] sheets show the best display of drumlins, though other sheets exhibit numerous and interesting forms.

In the zones of wave erosion by the glacial lakes the drumlins were cut or entirely removed. Lakes Warren and Dana were too short-lived in the Ontario basin to do more destructive work than cutting notches in the drumlins and building the debris into adjoining gravel spits and bars [pl. 17]. The same applies to Lake Iroquois in its great Cayuga-Syracuse embayment, reaching from Sodus to Richland. But along the continuous or maturer shore of Iroquois, extending from Niagara river to Sodus and from Richland to Watertown, as well as along the living shore of Ontario, no drumlin has been able to stand up alone against the waves;

DUCATION DEPARTMENT
JOHN M. CLARKE
STATE GEOLOGIST

UNIVERSITY OF THE STATE OF NEW YORK
STATE MUSEUM

BULLETIN 111 PLATE 6



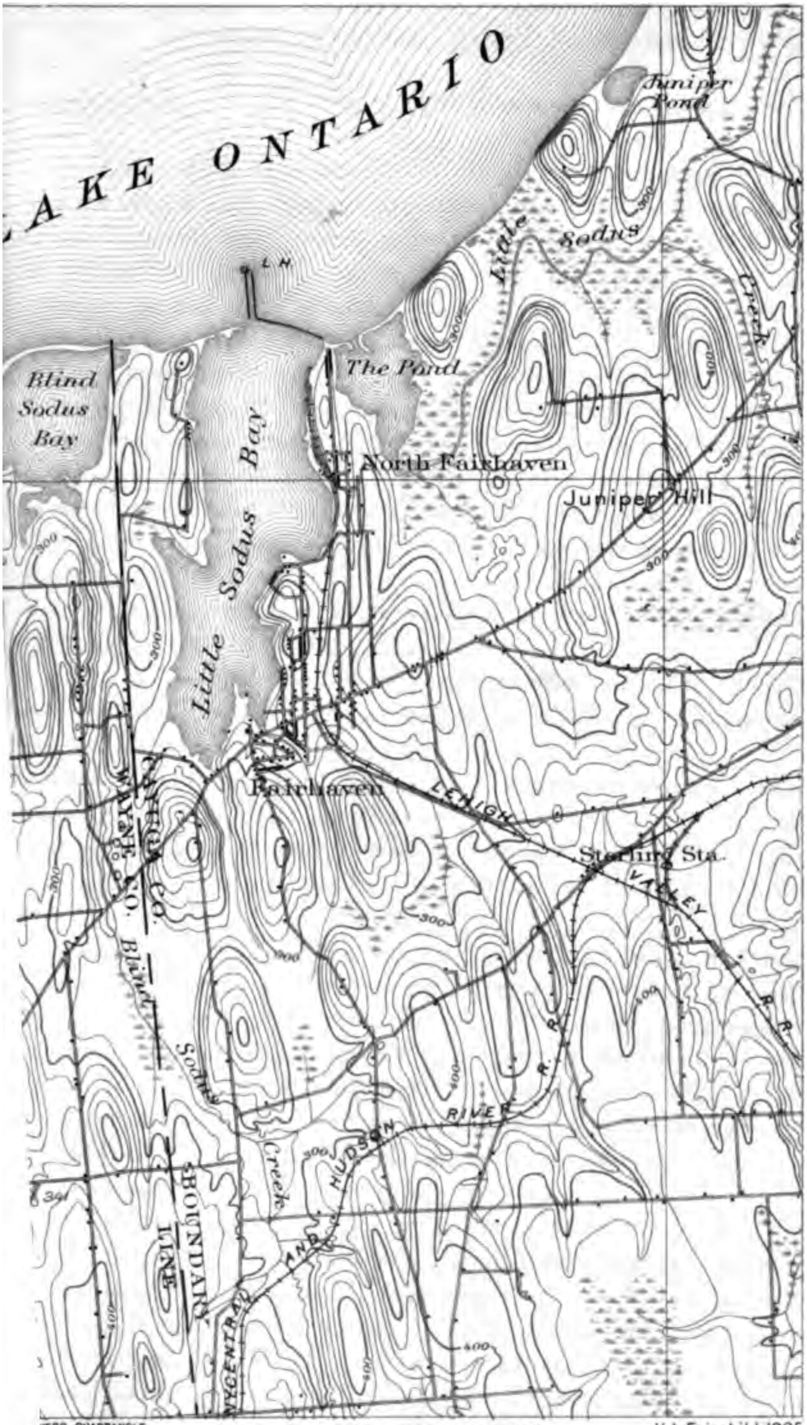
FULTON QUADRANGLE

H.L.Fairchild 1905

LONG-RIDGE DRUMLINS AND OVERLAPPING MORAINE

Moraine overlaps and replaces the drumlins on the north. Only the north border of the drumlin area is shaded.

ATION DEPARTMENT UNIVERSITY OF THE STATE OF NEW YORK
HN M. CLARKE STATE MUSEUM BULLETIN 111 PLATE 7
ATE GEOLOGIST



FAIRHAVEN DRUMLINS

These broad ovals are nearer the dome-form than any other group in New York.

although they survived where immersed in more than 30 or 40 feet of water.

At Sodus village the Iroquois beach, the "Ridge road," is an erosion cliff in several strong drumlins. Westward the north border of the Syracuse-Rochester drumlin area swings to the south of the beach and follows about west-southwest to the Genesee river, and thence west and north of west to the limits of the area northwest of Batavia. The following places in order westward lie at the northern limit of abundant drumlins: Sodus, Williamson, Lincoln, Penfield, Pittsford, Churchville, Bergen, Oak Orchard Swamp.

Eastward from Sodus the Iroquois shore with less maturity curves southward around Sodus bay, but still marks a north limit of the close set drumlins. The villages along this border are: South Sodus, Wayne Center, Rose, West Butler, the line passing 2 miles southeast of Wolcott. The northern border of the Syracuse-Rochester area curves so as to lie approximately at right angles to the axial direction of the drumlins.

South and east from Sodus bay, over the Montezuma and Oneida lowlands, the groups of drumlins stood as islands in the Iroquois waters.

East and northeast from Sodus bay a somewhat distinct area of heavy drumlins borders the shore of Ontario; and it is this series which passes around the east end of the lake toward Watertown. The villages of Fairhaven, Fulton, Mexico and Pulaski lie in this area.

Passing lakeward from the Iroquois beach, into what had been deep waters, a belt of drift forms, moraine or drumlins, gradually appears which is abruptly terminated by the present Ontario beach. It would be interesting to know if the waters of Ontario hide drumlins in their depths. As a series of heavy drumlins are opposing the waves all the way from Sodus to Oswego [pl. 7, 8], it seems quite certain that northern members of the group have escaped destruction by submersion in the deeper waters.

The southern limits of the great drumlin area are even less definite than the northern and can not be tersely stated. Approximately they may be given as follows: The western extremity of the area is bounded on the south by the shore of the ancient Lake Warren from Indian Falls to Leroy. From Leroy the drumlins spread south up the west slope of the Genesee valley to Mount

EW YORK

NTARIO WAV

Mc
fee
the
ing
an
en
eas
wh
sou
loc
Ca
an

l
co
Fir
ap
the

di
sou
At
on
val
an

gr
mc
pa
Ge

de
se

Ir
an
m
th
di

Chautauqua lake, with direction pointing southeast [pl. 21]. Another group occurs about the north end of Cazenovia lake, with altitude up to 1400 feet. Scattering drumlins occur in many localities, and probably at even higher altitudes than noted above.

The amount of land surface included in the principal drumlin area is roughly estimated as 2500 square miles without including the portion east of Lake Ontario.

Some of the peculiarities of the main drumlin series, the Oakfield-Syracuse, in the matter of definite boundaries and minor grouping should be noted here. These features, though difficult of verbal description, appear very striking on a large map made by joining the topographic sheets. Along the northern border of this series from Sodus east to Irondequoit depression the drumlins are quite abruptly replaced by morainic topography [pl. 15], the relationship being discussed later [p. 424]. The north border of the eastern Ontario series shows the change from drumlins to moraine even more plainly [pl. 6].

On the southern borders the drumlin topography sometimes shades off into smooth drift [pl. 13], while in other districts it is lost in the bolder relief of the rock hills [pl. 16].

The most abrupt ending of the drumlin topography is along the courses of ancient glacial river drainage. A series of drainage channels marks the definite southern limit of the second drumlin series from Victor to Geneva, and on the west of the Genesee at Leroy and Mumford. A later drainage course, from Fairport to Syracuse, traverses the heart of the drumlin series, and seems responsible for the isolation of minor groups, the peculiar forms of which are indicated in plates 9 to 12.

Orientation

The attitude of the drumlins with reference to compass direction varies according to their position in the area. The angular directions of their longer axes cover nearly a half circle. In the district east of Lake Ontario they point east, that is they were shaped by a movement of the ice from the west. As we pass westward around the south side of Ontario we find the direction gradually shifting to southeast, then to south, and finally in western New York to southwest; while on the Niagara-Genesee prairie, in the northwest part of the State, the direction is southwest by west. This radial direction is shown on the general map, plate 1, and the smaller maps, plates 5 to 17, show the attitude and forms within the 20 foot contours.

The long axes of the drumlins indicate the direction of the latest vigorous movement of the ice sheet in their locality, and the variant directions of the drumlins throughout the whole area prove a radial or spreading flow of the ice mass that rested in the Ontario basin during the stage of waning which is represented by the drumlin formation.

This consonance of the drumlin attitude to the latest ice flow direction is strikingly confirmed by the study of the drumlins in outlying districts. The Chautauqua drumlins point southeast, in harmony with the spreading flow of the Erian lobe of the waning ice sheet. On the other hand, the drumlins of the Watertown district, east of Lake Ontario, point southwest, conforming to the latest flow of the thinning ice in the St Lawrence valley.

Another interesting fact to be noted in this connection is that the axial direction is not always uniform along the same meridian. If the topographic control over the ice movement changed with the varying latitude of the ice front, as the latter was receding, the drumlins record that fact. For example, 20 miles south of Rochester the ice margin was guided by the Conesus, Hemlock and Honeoye valleys and the drumlins are north and south. But on the same meridian, only 6 to 12 miles south of Rochester, the drumlins point to the southwest, the ice margin being controlled by the Genesee valley and the thrust being from the northeast.

The radial or spreading flow of the ice at any single stage must be found by a comparison of the drumlin directions within a single series of drumlins, that is, drumlins which were formed simultaneously. If we take the second, or Oakfield-Syracuse, series we find the axial directions point as follows: At Oakfield, s. 55° to 60° w.; Fairport to Palmyra south; Syracuse, s. 30° e. Taking the third, or eastern Ontario, series, the drumlins are north and south at Sodus bay; at Oswego, s. 30° e.; Mexico, southeast; Pulaski, e. 20° s.; Sandy Creek, east.

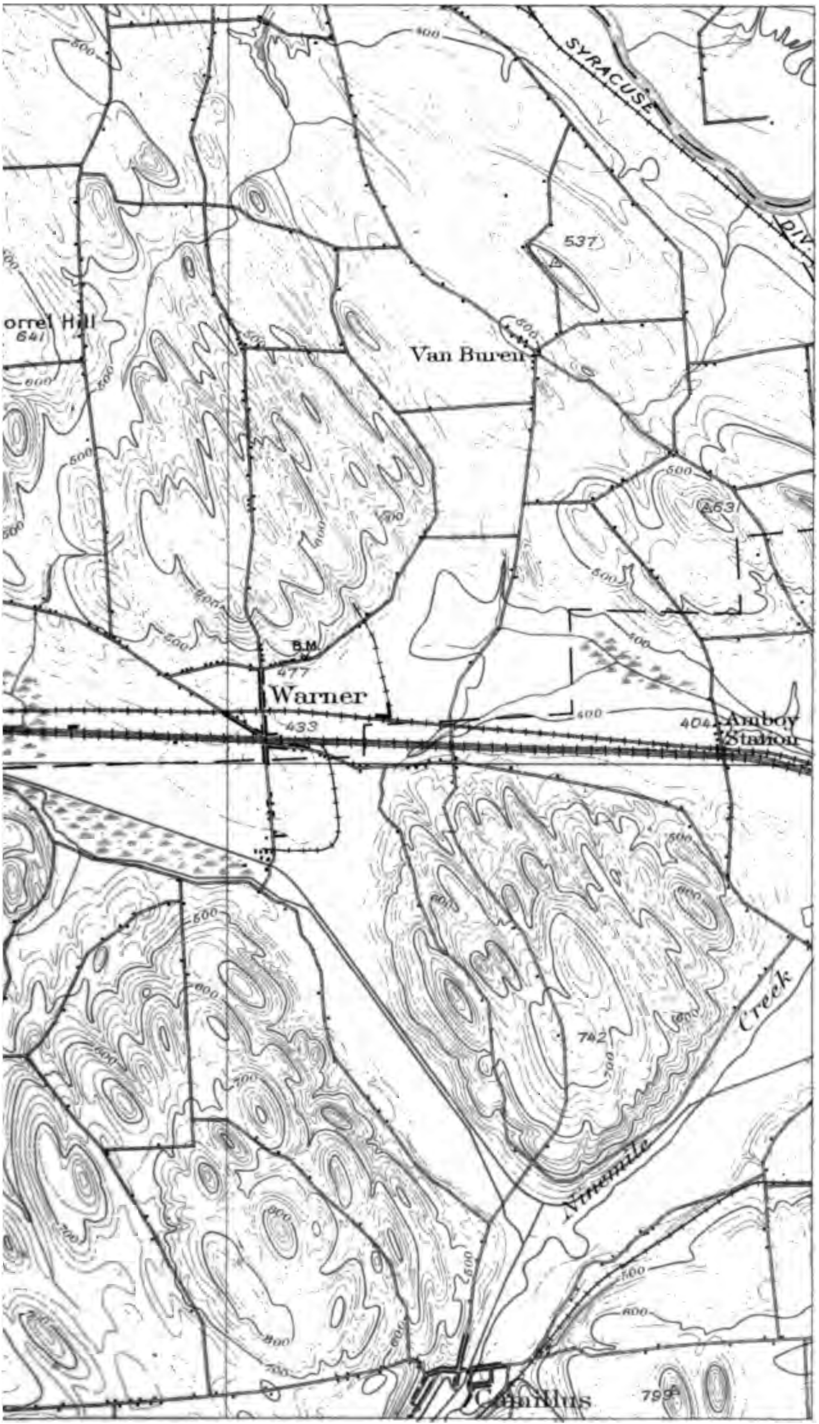
A peculiar confirmation of the genetic relation between drumlin attitude and ice-flow direction is found in the Pulaski region. Passing northeastward around the corner of Lake Ontario (Mexico

UCATION DEPARTMENT
OHN M. CLARKE
TATE GEOLOGIST

UNIVERSITY OF THE STATE OF NEW YORK

STATE MUSEUM

BULLETIN 111 PLATE 9



OF BALDWINSVILLE QUADRANGLE

H. L. Fairchild 1905

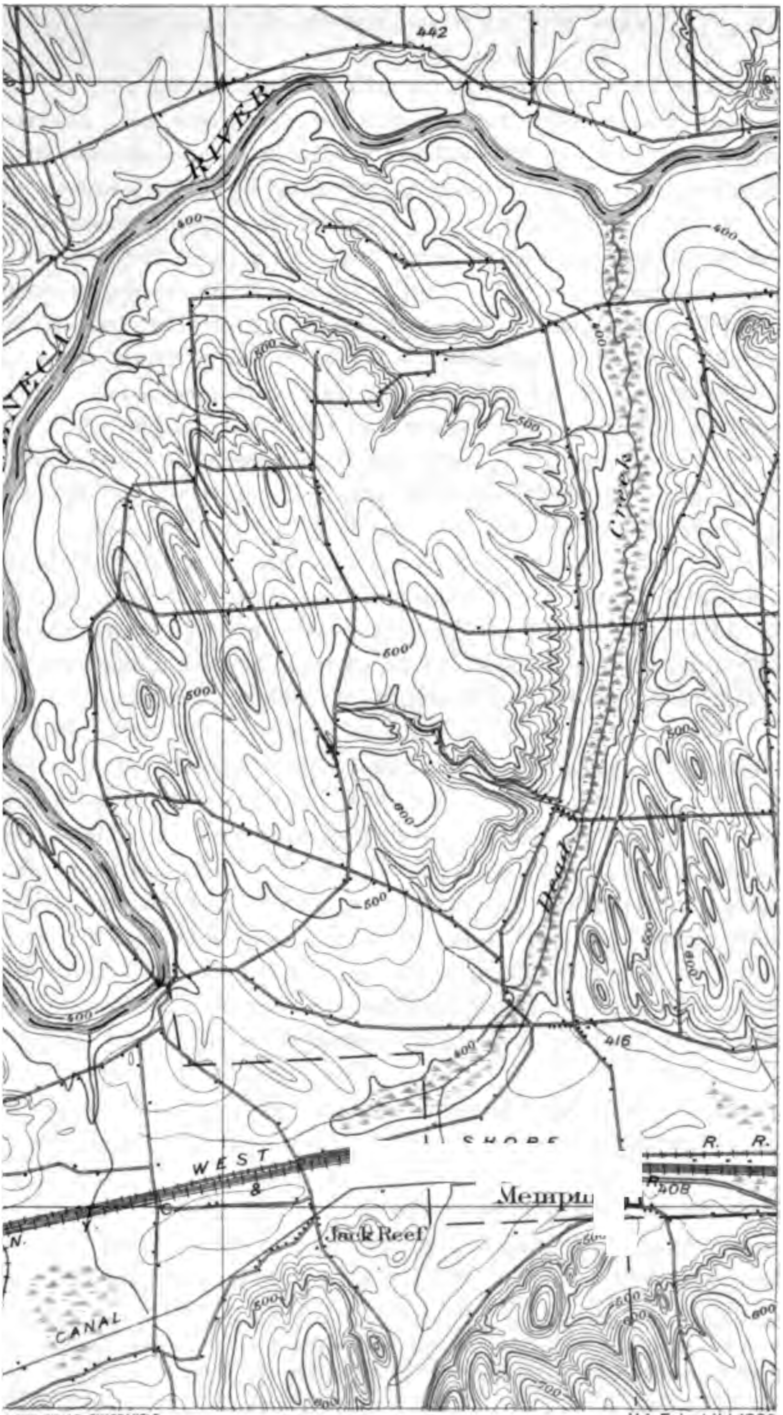
DRUMLINS GROUPED IN ISLAND MASSES

The valleys are carved in Salina shale, which forms at least the base of the drumlins up to 500 feet or higher.

ON DEPARTMENT UNIVERSITY OF T STATE OF W YORK
M. CLARKE
E GEOLOGIST

STATE MUSEUM

BULLETIN 111 PLATE 10



ALDWINSVILLE QUADRANGLE.

H.L.Fairchild 1905

DRUMLOIDS

The drumlin-shaped forms in the upper part of the map are Salina (Vernon) shale.

bay) we find, as noted above, that the direction toward which the drumlins point veers from southeast to east. But as we pass on north some 10 miles, to Ellisburg and Belleville, we find the drumlins pointing southwest, or in direction nearly opposed to the drumlins between Oswego and Mexico.

These opposing directions represent ice-flow movement at different stages of the waning ice body. While the Ontarian mass yet covered the Oswego-Pulaski district the radial flow produced the forms which point southeast at Oswego and east at Sandy Creek. But during the latest stage of the ice in the basin the flow of the St Lawrence-valley lobe produced the southwest-pointing forms between Ellisburg and Watertown.

It will now be recognized that if the southeast-pointing forms were made by an earlier flow of the same waning ice mass that produced the later southwest-directed forms then somewhere between the two opposing forms the drumlinized drift should indicate a turning, swinging or pivotal motion of the ice. As a matter of fact the drumlins in the district east of Mexico bay do show the complexity of form and direction required by the theory of ice movement stated above.[1]

Seen in the field, on the ground, the drumlins of the Pulaski district show peculiarities of form which the map contours do not suggest and which are puzzling and apparently inconsistent. The main drumlin forms, as shown on the map [pl. 5], point southeast to east. As seen from the north or south the characteristic profile is usually clear, but with change in point of view, looking from west or east, one sees instead of the expected end view or cross-section profile the peculiar longitudinal profile of the drumlin oval. Many of these contrawise forms should have received expression on the topographic sheets.

From whatever direction we view many of these hills the drumlin form appears. In many cases one detects a faint but distinct molding of the drift in direction highly inclined to the main form. Sometimes an irregular surface which is regarded as morainal becomes equivocal or even decidedly ice-molded with a change in point of view. There are patches of emphatic moraine surface and in some areas, as north and west of Pulaski, the moraine character prevails. Frequently a drumlin form as viewed from some distance becomes irregular and morainal in minor relief on nearer view. Sometimes the moraine surface is equally puzzling; smooth ridging or ribbing making one doubtful whether to map the area as moraine or drumlinized drift. Such areas occur southwest of Pulaski [pl. 5] and northwest of Sandy Creek.

---

[1] This is not a case of finding that for which one is looking. The following observations relating to the peculiar forms of the Pulaski drumlins were made and the facts recorded as side notes while making special study of other phenomena, and their significance was not appreciated at the time.

One important point which has a bearing on the origin of drumlins should be noted here. The secondary or contrawise forms do not seem to have been made by the cutting or carving of the primary forms but to have been produced by the addition or plastering on of the later form. The work seems to have been constructional, not erosional.

The explanation of these exceptional features would seem to be that the main and larger drumlin forms were made by the eastward motion of the ice; and that the minor molding, at a high angle and usually southward, was produced when the waning ice in this district felt directly the thrust from the St Lawrence valley. It does not appear that the molding of the drift is pronounced in directions intermediate between eastward and southward. Possibly while the ice flow was changing from eastward to southward it was not relatively so vigorous, but it is more probable that only the latest of the minor ridging is conspicuously preserved.

Relation to larger topography

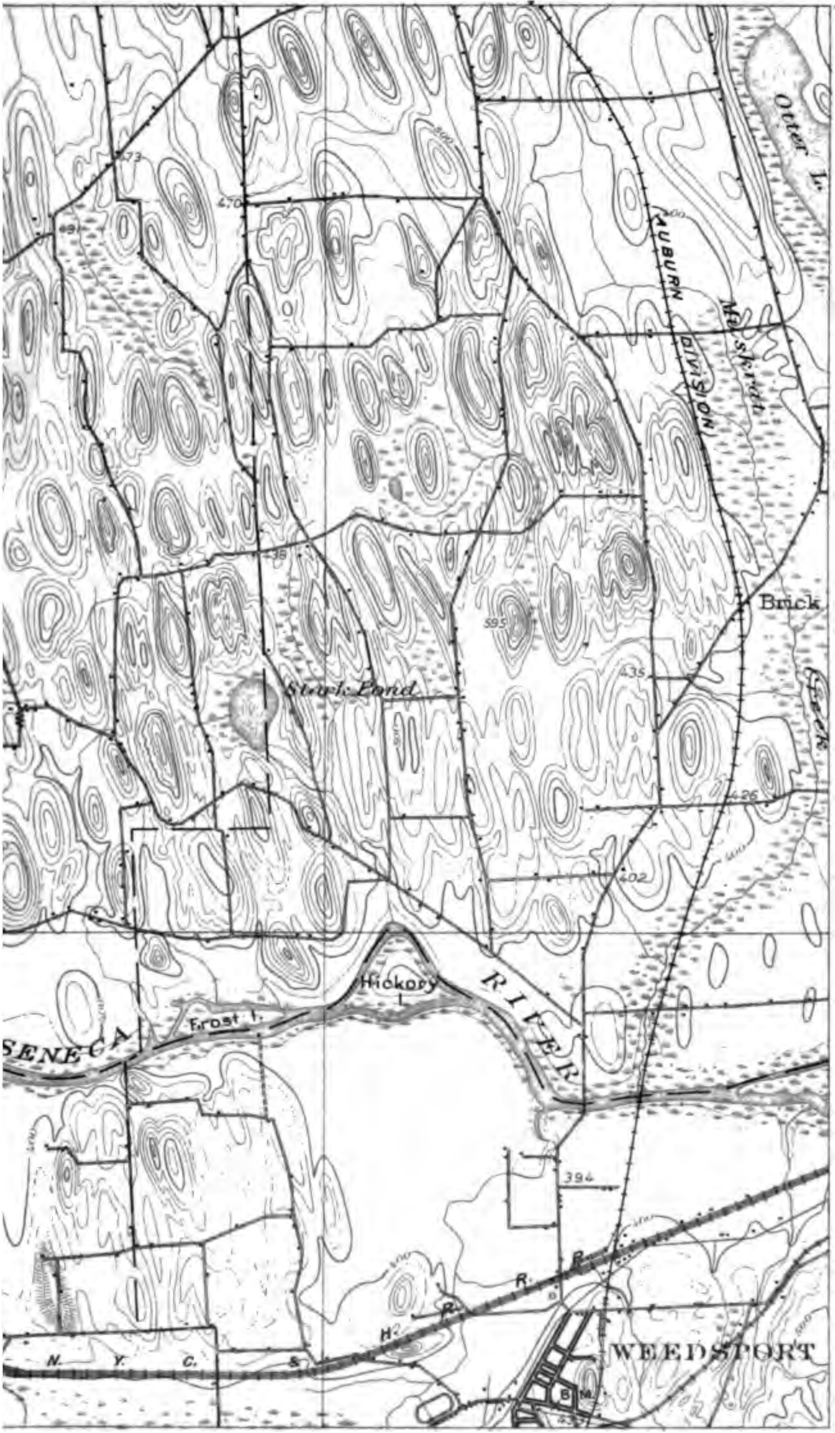
A glance at plate 1 shows that the general drumlin area covers ground of all altitudes from the level of Lake Ontario (and they probably occur in the depths of Ontario) up to about 1700 feet; this highest edge of the drumlin belt lying west of Canandaigua lake [pl 16]. West of the Seneca valley they usually reach up to high ground, 1100 to 1500 feet. In the low north and south depression of the Seneca and Cayuga valleys, where we might expect them to be well developed, they are weak or wanting above 500 or 600 feet [pl. 3, fig 2]. While scattering drumlins may occur in poor form between the eastern members of the Finger lakes it may be emphatically stated that the area of close set and well developed drumlins does not reach south on the high ground east of Seneca lake, but that extensions of the drumlin area do reach up on the high ground west of Seneca lake and as far west as to the

UCATION DEPARTMENT
OHN M. CLARKE
TATE GEOLOGIST

UNIVERSITY OF THE STATE OF NEW YORK

STATE MUSEUM

BULLETIN 111 PLATE 11



RT OF WEEDSPORT QUADRANGLE.

TYPICAL OVAL DRUMLINS

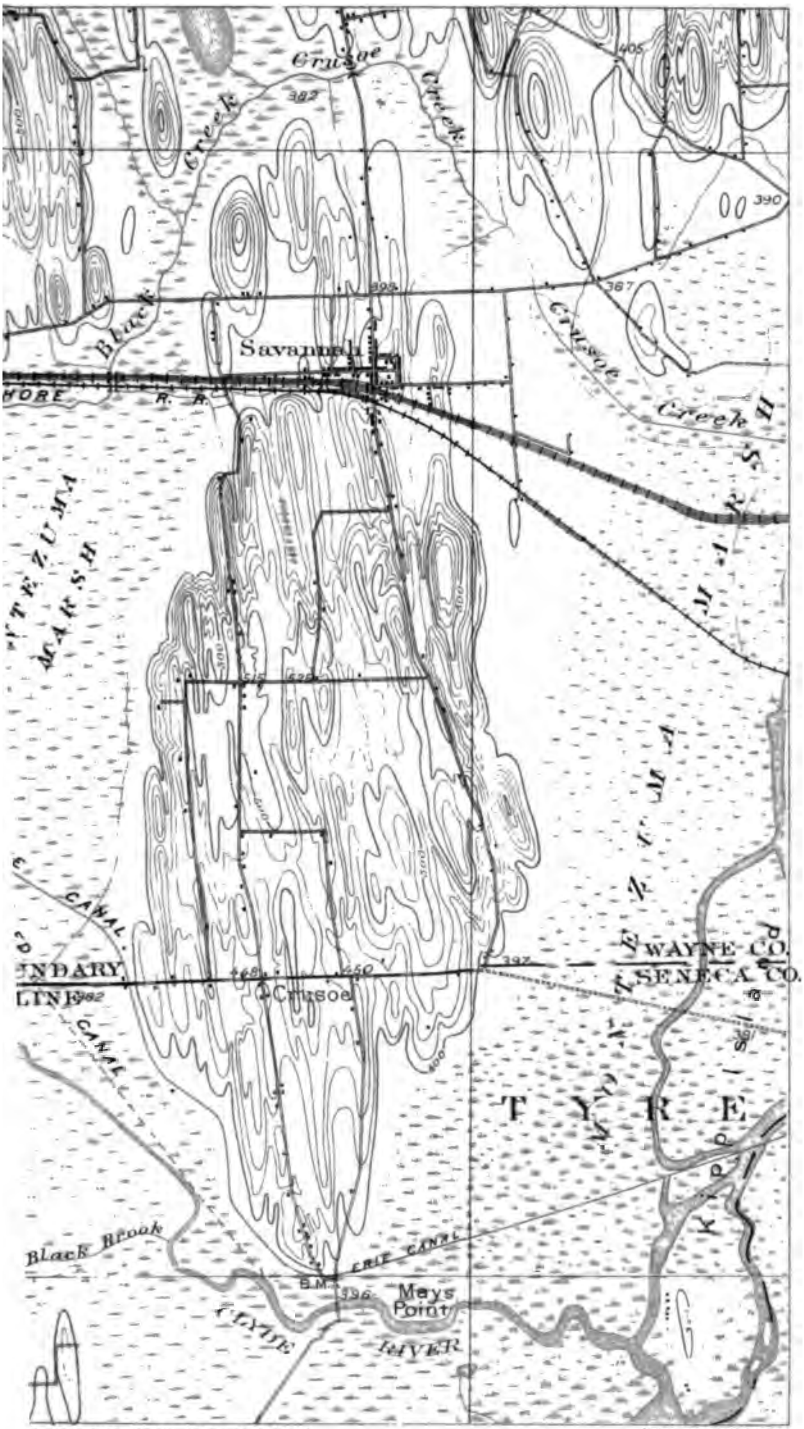
H.L.Fairchild 1905

TION DEPARTMENT
N M. CLARKE
E GEOLOGIST

UNIVERSITY OF THE STATE OF NEW YORK

STATE MUSEUM

BULLETIN 111 PLATE 12



E, WEEDSPORT, GENEVA, AUBURN QUADRANGLES.

H.L.Fairchild 1905

DRUMLIN MASS IN MONTEZUMA MARSHES

The "heart" of the drumlin area.

Tonawanda valley. This distribution of the drumlins indicates that altitude and grosser topography are not alone controlling factors in the drumlin formation.

The most massive development of the drumlins is on the low ground north of the Finger lakes, and chiefly under 500 feet altitude. This great development of the drumlins on the low Ontario plain and their comparative absence on the higher ground facing the ice sheet is most striking in the central and eastern part of the drumlin belt.

It is important to note that the district of highland drumlins, the western extension of the drumlin area, is where the later ice movement and the drumlin direction coincide with the general direction of the main ice movement, that is, toward the southwest; while the district of no elevated drumlins, east of Seneca valley, is where the drumlin direction is oblique or nearly at right angles to the direction of flow of the thicker ice.

The production or nonproduction of drumlins is believed to depend in part on the abundance and character of the bottom drift of the ice sheet, but chiefly on the active movement of the bottom ice, due to thrust from the rear. The absence of strong drumlins on the gently ascending slopes between Seneca and Owasco lakes may be partly due to the capacious preglacial valleys in the area north of the Finger lakes, which served as catchment for the lower drift. The absence of any large amount of drift, in the form of either drumlins or moraines, in the belt of open valleys [pl. 2] suggests that the last ice which lay on this territory was comparatively clear of drift. It would seem that the greater burden of drift had been either rafted over the level of the open valleys to the higher valley heads moraine farther south, or was held in the lowest ice, and built into the drumlins farther north.

As stated above [p 369] the land surface east of Syracuse never felt the rubbing action of the ice sheet The Syracuse district was subjected to the thrust of a tongue of ice pushed southeastward from the spreading Ontarian mass. The southeastward and southward flow was not sufficient to reach the land surface over the Oneida lake region nor over the high ground east of Seneca valley. However, the land surface west of the Seneca valley, lying where the latest ice movement was the same as the principal ice movement, toward the southwest, felt the molding effect of the ice thrust during the waning stage.

Relation to underlying rock strata

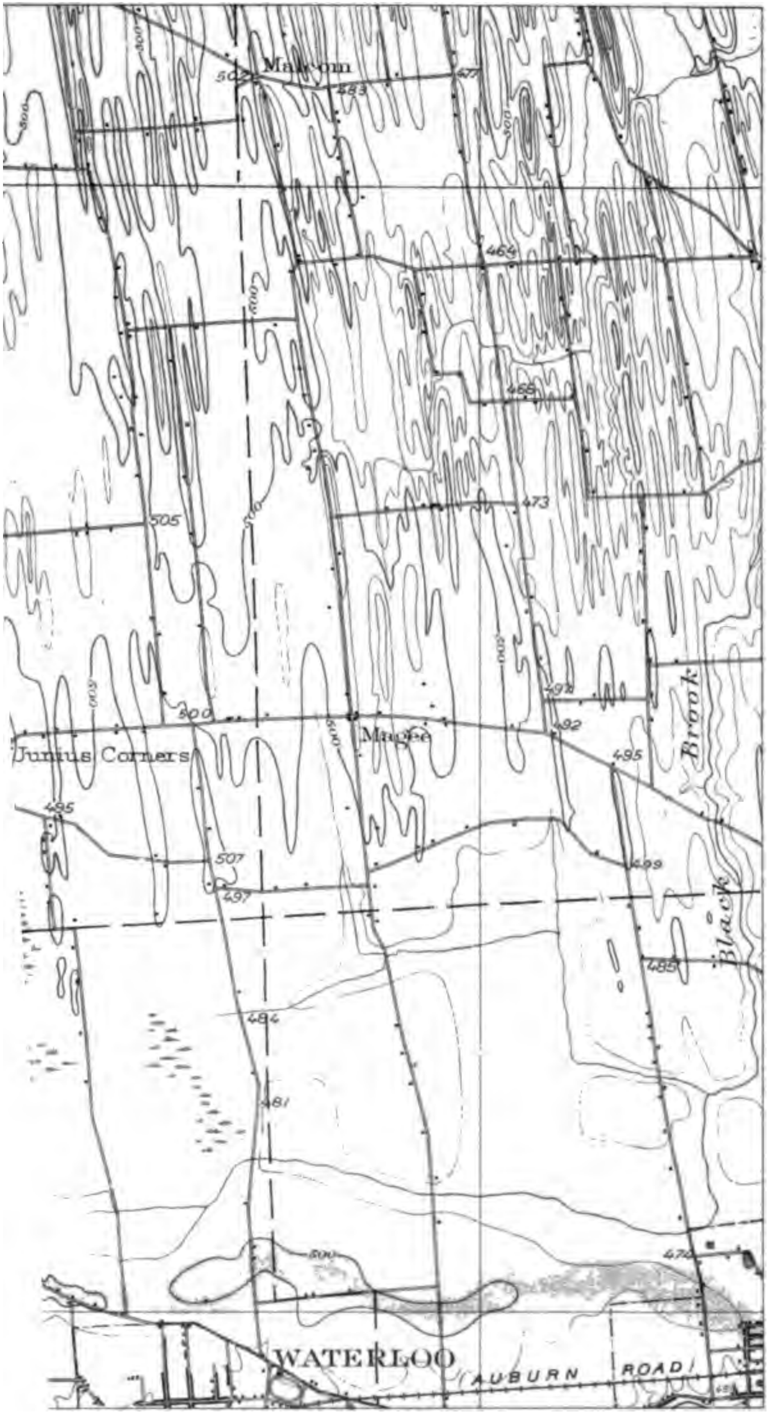
A glance at any stratigraphic map of New York State will sho that the dominant drumlin area, north of the Finger lakes, lies on the low ground north of the outcrop of limestones formerly called Helderberg and Corniferous and over the belt of strata now know as Cayugan (Salina), Niagaran and Oswegan (Medina), naming then in descending stratigraphic order, or from south to north. Thes strata are chiefly shales, with relatively thin limestones in th Niagaran and some sandstone beds in the Oswegan.

The following table gives the approximate thickness of the severa strata along the Cayuga meridian (corrections supplied by Mr C. A Hartnagel of the State Geological Survey).

New York rocks along the Cayuga meridian

Divisions		Thickness in feet	Kind of rock
Erian	Hamilton	1 140	Shale
	Marcellus	80	Shale
Ulsterian	Onondaga	80	Limestone
Oriskanian	Oriskany	3	Sandstone
Cayugan	Manlius	70	Limestone
	Rondout		Limestone
	Cobleskill	6	Limestone
	Salina	1 400	Shale
Niagaran	Lockport	320	Limestone
	Rochester		Shale
	Clinton	80	Shale and limeston
Oswegan	Medina	950	Shale and sandston
	Oswego	200	Sandstone
Cincinnatian	Lorraine	820	Shale
	Utica		Shale

The drift supply for the drumlins of any district was deriv mainly from the strata immediately northward. The above tab shows that rocks beneath the limestones which inclose the Oriska are mainly shales of great thickness. Counting the Medi as one fourth sandstone and the Niagaran as half limestone have 3130 feet of shale, 200 feet of limestone and 440 feet



GENEVA QUADRANGLES.

H.L.Fairchild 1905

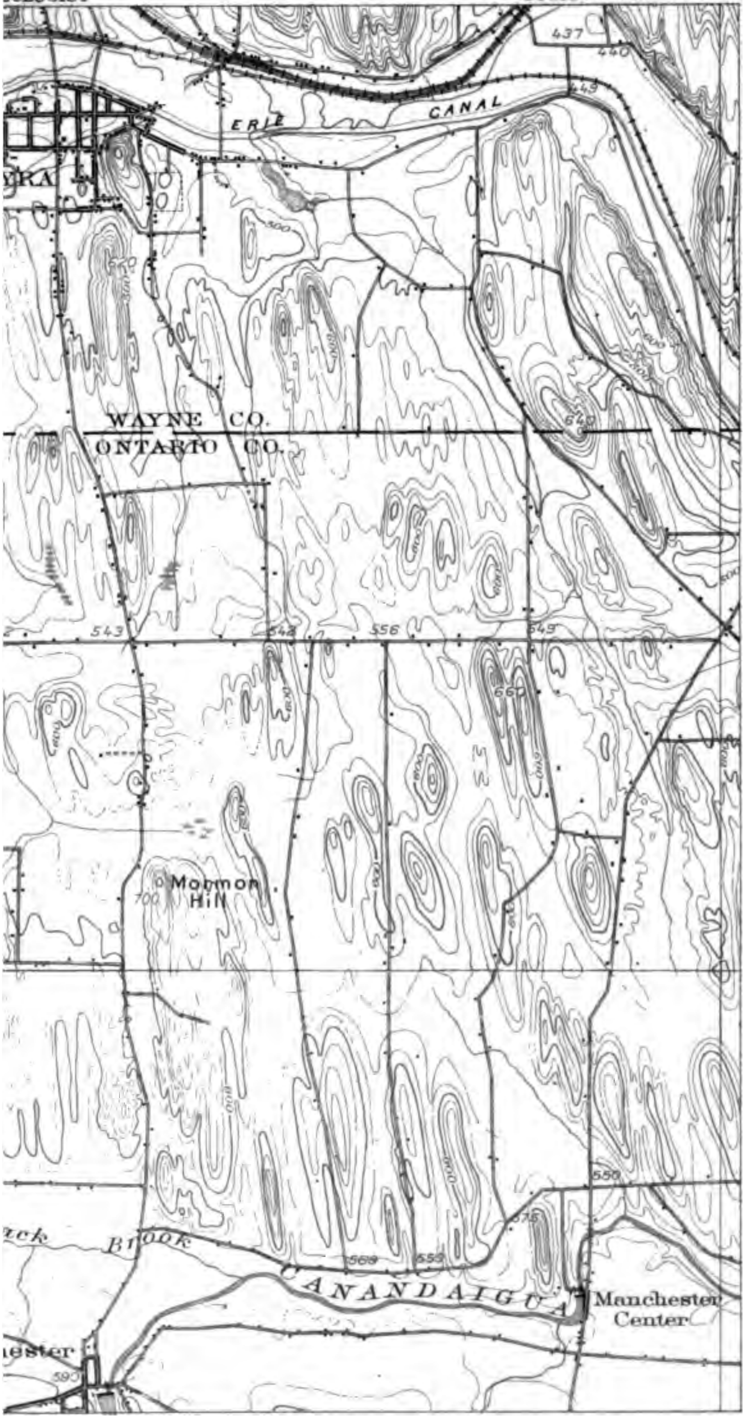
UTH EDGE OF THE MAIN DRUMLIN SERIES

The terminal moraine lies in front of the attenuated drumlin border.

EPARTMENT UNIVERSITY OF THE STATE OF NEW YORK
CLARKE
EOLOGIST

STATE MUSEUM

BULLETIN 111 PLATE 14



A AND PHELPS QUADRANGLES.

H.L.Fairchild 1905

DRUMLINS OF THE MORMON HILL GROUP

The south termination is abrupt against a glacial river channel.

sandstone. All these strata have a decided southward dip which gave outcrops projecting northward against the ice advance. By long eras of preglacial weathering these exposures of shale and limestone afforded a large supply of plastic drift to the bottom ice. It is believed that the rock rubbish was not in any stage of the ice work carried far away, but on the contrary was plastered into the drumlin masses. The thick clay strata supplied a burden of unusually clayey and adhesive drift; and it seems probable that the adhesive and plastic character of the lower drift was a contributory factor in the upbuilding of the drumlins, specially the taller ones.

Form and dimensions

These elements are very variable. The ordinary shape of the drumlins in western New York is an elongated oval, the length being three to five times the breadth. Occasionally they are short ovals, and rarely approach the mammillary form, but much more frequently they are long or attenuated ridges. The elongated or ridge form is the characteristic New York type, though other forms occur frequently, except the dome.

Considering horizontal dimensions the several types may be distinguished as the mammilla or dome; the oval; the slender oval or short ridge; and the linear or attenuated ridge. The two latter forms include the great majority of New York drumlins. It is an important fact that the several types are not intermingled but are separately grouped, certain districts exhibiting some particular type almost exclusively. This is fairly illustrated in selections from the topographic sheets; the oval form, large and small, being shown in plates 7 and 11, the Fairhaven, Syracuse and Weedsport districts; plates 12 and 14 showing the short ridges in the Clyde-Palmyra district; while the long ridges are shown in plates 6 and 19, the Oswego district and the Niagara-Genesee prairie. The very slender, linear ridges are often too low or weak to be shown by 20 foot contours, but an example which appears on the map is here given as plate 13, the district north of Waterloo and Seneca Falls.

The lengthwise profile of the shorter drumlins is an elegant curve, convex to the sky, and characteristically more abrupt or steeper at the north end. The crest line of the longer ridges is commonly almost a straight line, which appears to the eye as true as if cut to a "straightedge" [pl. 30]. The south ends of all drumlins, except the steeper ovals and domes, taper off into the general sheet of till unless eroded by waves or other agency.

In cross-section the variation of profile is more limited than in longitudinal section. The summits naturally have a symmetric curve. Unsymmetric but yet convex summits may be produced by the drumlin process, but sharp crests, as in plates 29, 34 and 36 are regarded as an effect of later erosion. In some cases the erosion of the sides of the drumlin has gone so far as to gnaw into the summit and produce a scalloped or wavy or broken crest line. As a rule the shorter drumlins have the flatter cross-section profile, while the long and the linear ridges may have either a crest curve of short radius with steep side slopes or a broad summit and semicircular cross profile.

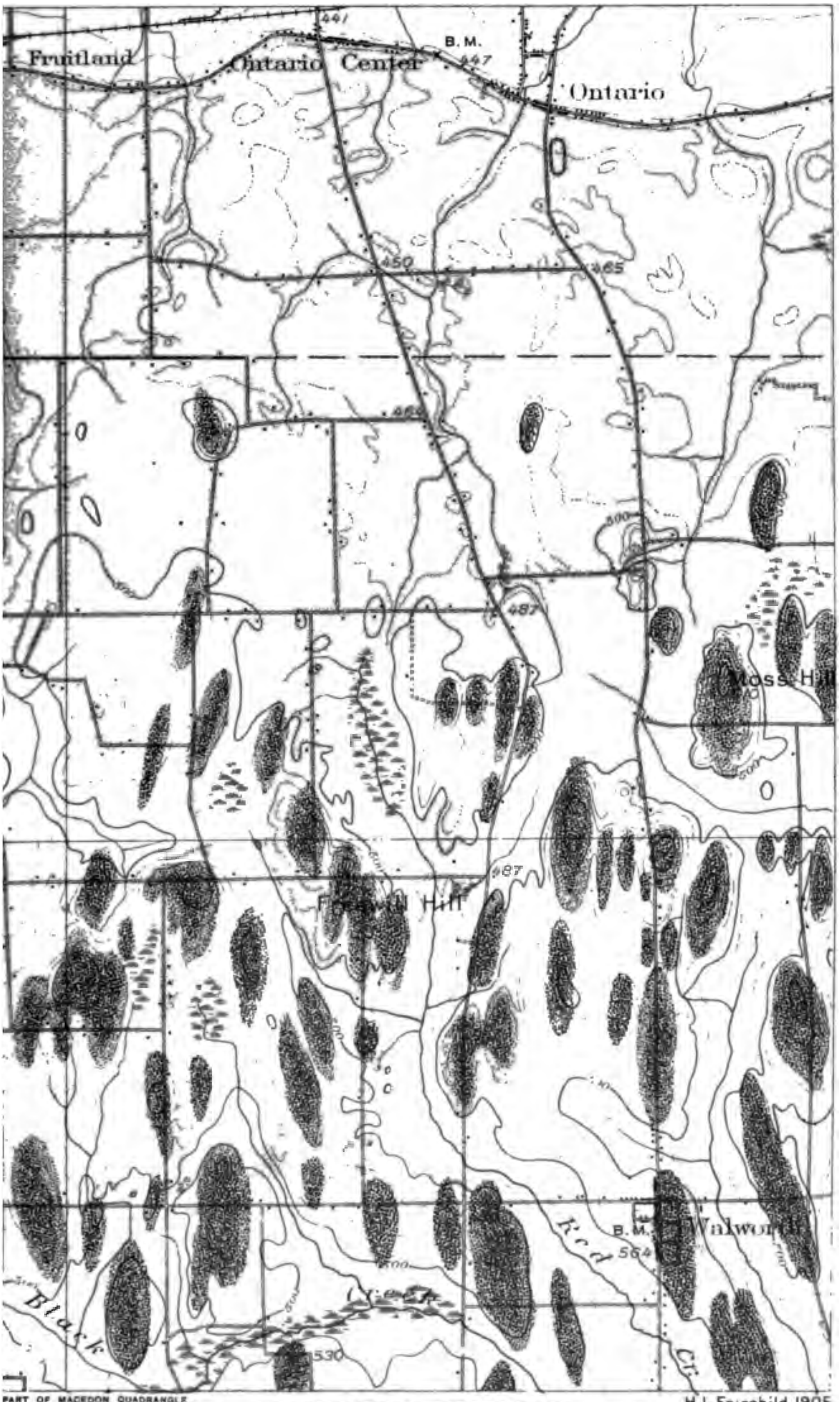
The junction of the convex drumlin with the horizontal ground surface naturally gives a concave slope at the drumlin base. Above this concave basal slope all drumlin surfaces are regarded as normally convex, and departures from convexity are due to some interference with the constructive process or to some subsequent effect. Two or more drumlins may overlap, or blend, or even be superposed [*see* p. 409] so as to produce irregular or unusual forms. Morainal drift is frequently banked against the sides and bases of the drumlins so as to change the true form. Erosion by the waters of glacial outflow may have cut the slopes and even the crests of drumlins, but decided crest cutting has been infrequently seen in New York, though conspicuous in Massachusetts.[1]

Vertical ridging or ribbing of the side of the drumlin is thought to be positively erosional, either by glacial waters or by postglacial storm wash and weathering. On the other hand longitudinal fluting or molding is regarded as a constructional effect of the drumlin-making progress.

With very few exceptions the drumlins are cleared of timber and their surfaces are under cultivation, as they afford the best soils. Some of the minor irregularities of surface may be subdued by the farm cultivation, but when the elements contributing to their erosion are considered it is remarkable that they are so well preserved. In the great majority of cases they seem to preserve their original form with practically their natural surfaces.

---

[1] Barton, George H. Glacial Origin of Channels on Drumlins. Geol. Soc. Am. Bul. 6: 8–13.



PART OF MACEDON QUADRANGLE.

H. L. Fairchild 1905

WALWORTH DRUMLINS

Moraine drift is scattered among the drumlins, wholly replacing them on the north. The Iroquois beach ("Ridge road") forms, by erosion, the north limit of the moraine.

The type of form least exemplified in New York is the dome-shaped. While such may rarely be found they certainly do not characterize any district. The group of drumlins which most nearly approaches the mammillary form, judging from the topographic sheets, lies in the neighborhood of Fairhaven bay, and is partly shown in plate 7. The oval form is excellently shown on the Weedsport sheet [pl. 11]. The long oval or short ridge, the "dolphin back" shape, probably includes a majority of all the New York drumlins, and is the most widely distributed. A massive development may be seen on the Palmyra sheet, plate 4. Probably this form should be regarded as the typical drumlin form, from which the dome on the one hand and the linear ridge on the other are extreme variations.

The long drumlin ridges, which are specially pronounced in New York and are therefore regarded as the New York type, are well displayed on the Clyde, Auburn, Oswego and Brockport sheets. There are two extreme varieties of the ridge form, the large and the small. The large form includes broad, low swells or rolls which if lying alone or far separated may not be recognized as of drumlin nature. They are not often indicated by the map contouring. These low, broad moldings of the till are the common and only form over most of the surface of the Niagara-Genesee prairie. Passing west on the Rome, Watertown and Ogdensburg Railroad, the change can be readily seen from quite typical long drumlins near the Genesee river [pl. 18] to very long swells of low relief, which if not at all indicated by the 20 foot contours may be recognized by the shallow cuts for the railroad grade. Westward these rolls gradually fade into gentle undulations of the surface, quite imperceptible except by the up and down grades of the railroad. Large areas are perfectly flat to the eye. Buildings are visible for miles in different directions on the plain unless hidden by trees. The roads stretch great distances, ending to view only by the overarching shade trees or by a turn in direction. That this smooth country has been ice-molded is shown by the stream flow, which is northeast or decidedly oblique to the general slope. The low relief and the oblique stream control is well shown in plate 19.

These southwest-pointing drumlin ridges occur in strong development southwest of Alden and west and southwest of Buffalo over the lower and smoother plain. The contouring on the Erie county sheets, the Attica, Depew, Buffalo, and other quadrangles to the south, fails to properly indicate the drumlinizing of the land surface. As the ridges lie in the smooth country occupied by the glacial Lake Warren and the subsequent falling waters, and as they have the southwest direction parallel with the general contours and the lake shore lines, some of the smaller ridges are liable to be mistaken, in distant view, for huge wave-built bars or beaches.

The small variety of the long ridges is displayed in the Lyons-Clyde-Savannah district, where the primary drumlins include between them a secondary or minor order of ridges. These inferior ridges are straight, parallel, side by side, and often not larger than large railway embankments. They are not good subjects for photography but plates 32 and 33 are examples. These attenuated, intermediate ridges prove the molding action of the ice, and its drumlin making tendency, even in the hollows between the larger structures. The major and minor ridges taken together suggest comparison with a piece of wood molding "struck" by the planing machine. This comparison is even better if we take the drumlins which exhibit longitudinal ribbing or fluting along their sides or bases. This longitudinal molding on the slopes of drumlins is certainly constructional and not due to any subsequent or erosional effect, as are the vertical forms.[1]

To the observant traveler on the railroads between Rochester and Syracuse the statement that the longitudinal drumlin profile is always convex seems untrue, because decided concave notching may be seen on both north and south ends of the drumlins. These are due to subsequent wave erosion by glacial lake waters. Some work of this kind was done at higher levels by the Warren and Dana waters [pl. 17], but the most conspicuous notching is in the area of the Iroquois waters. The pronounced erosive work illustrated on the shore of the living Ontario [pl. 7, 8] and along the "Ridge road" or ancient shore of the extinct Iroquois [pl. 4] may be seen in less degree but yet clearly between Lyons and Syracuse from the trains of the New York Central and the West Shore Railroads. Plates 36, 37 and 39 are views taken from the railroads.

---

[1] Speaking of these ridges D. F. Lincoln has said: "From this they grade downward to little ridgelike elevations of 5 feet in hight and a furlong in length. Even these are quite distinct to the eye, rising from the uniformly level plain."

rave cutting of the drumlins which held their heads up as in the Iroquois waters seems capricious. Some drumlins om their location must have been exposed to severe wave rom the direction of the heaviest winds (mainly northwest) d little effect, while others [pl. 38] which had more sheltered s or were exposed only to southerly winds are decidedly cut. unt of wave cutting seems to have depended in no small n the composition and texture of the till.

ngular effect of the end erosion of the isolated drumlins is bent appearance to the cut end. Oblique erosion of the y rounded end causes the crest line of the ridge to bend ruptly, to the leeward, from the axial line of the hill. In ses this change in the direction of the crest line is the best e of erosion, for it is believed that the original crest of the or struck end of the drumlin must have been true to the ie. Examples of these twisted-nose drumlins are rather hown in plates 36 and 37.

gular form of drumlin is found in the district south and st of Rochester, illustrated in plates 40 to 42. This sug- ne drumlin superposed on another; a sort of two-story They were first noted in connection with the search for es of Dana waters. Some of the concave slopes coincide e Dana level and possibly the features have been rarely ited by wave erosion, but the form is found at other levels. er, the surfaces of the two-story drumlins have the ers of ice molding, the lines are out of horizontality, and l characters wanting. The form is believed to be the of the ice work, and perhaps due to two stages of the con- nal process, or to a slight change in the direction of the ice nt.

double-deck drumlins have been found only in the district north end of the larger Genesee valley, and on either side valley. It is suggested that the variation or change in the ing process which caused this peculiarity in form may have ated to a change in the direction of ice flow due to the e of the Genesee valley on the thinning ice sheet.

ross profile of a drumlin is naturally subequal or symmetrical, e is modification of the slopes when two or more drumlins ose together, either side by side or in echelon, are crowded in their growth or even blended. Asymmetry may be due to some local variation in the ice movement, apart from the crowding in construction.

Sometimes the drumlins have an outline when seen endwise that resembles the normal longitudinal profile. This abnormal form has been seen frequently in Wayne county west and northwest of Walworth [pl. 15]. This form is not due to change of ice flow direction (which accounts for the similar appearances in the Pulaski district) but to irregular construction, and perhaps to ultimate union of primarily distinct drumlins. In the dominant drumlin area the growing drumlins seem to have frequently fused together so as to give unbalanced cross-section profiles, but such drumlin masses have in longitudinal outline the characteristic curve.

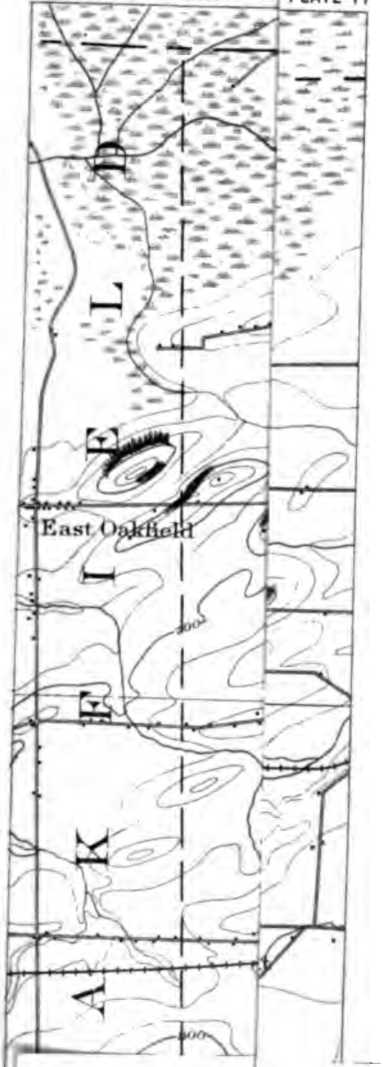
Dimensions. The size and dimensions of drumlins are variable, within limits, according to the quantity and quality of the drift and the depth and impulse of the ice sheet. The smaller or infantile drumlins do not usually have good or characteristic forms unless they are of the slender type or small, attenuated ridges, which may be small in cross-section and yet retain a distinctive character as ice-molded till.

There seems to be a limit to the hight of individual drumlins, this being in New York about 200 feet. Using the map contours for determining the base of the drumlin as well as the summit altitude (an inexact basis, with maximum error of 40 feet) only one drumlin is found with altitude over 200 feet. At some point the upbuilding process is antagonized by the eroding or leveling tendency and a balance is struck between the opposing forces which limits extreme hight, and results, apparently, in the production of multiple ridges of moderate size instead of one huge ridge. This principle seems to be illustrated in the form of the peculiar groups in the Syracuse region, described later [p. 429 and pl. 9].

The most conspicuous drumlins, striking because of their isolation, like those rising out of the Montezuma marshes, are not the highest. Using the map contours, as noted above, for approximate data along with the figures frequently given on the map for definite altitudes of many higher drumlins, the following table has been compiled. This gives the approximate altitudes of base and summit and the individual hight of a considerable number of New York drumlins in different districts.

EDUCATION DEPARTMENT
JOHN M. CLARKE
STATE GEOLOGIST

PLATE 17



Altitude and hight of highest drumlins

Designation	Base and summit altitudes	Hight
Meridian of Rochester		
Rider hill, 2 m. n.w. of West Rush	620–800	180
Huckleberry hill, 2 m. w. of Lima	900–1054	154
Jakman hill, 2 m. n.e. of Livonia	1040–1194	154
? hill, 1 m. n.w. of Livonia	920-1080	160
Meridian of Palmyra and Macedon		
Pigeon hill, 2½ m. n.w. of Marion	480-665	185
Triangulation station, 4 m. s.w. of Canandaigua	1040-1201	160
? hill, 1 m. n. of Palmyra	480 633	150
? hill, 2 m. n.e. of Palmyra	500–670	170
[1] Mormon hill, 4 m. s. of Palmyra	600-700	100
Meridian of Sodus-Newark		
Triangulation station, ½ m. w. of Sodus	440–595	155
Triangulation station, 1 m. s.w. of Sodus	460-620	160
Zurich hill, 5 m. s. of Sodus	440-640	200
Baker hill, 6 m. s. of Sodus	460–680	220
Triangulation station, 2 m. s. of Clifton Springs	700–860	160
Meridian of Sodus bay-Clyde		
Chimney bluff, 2 m. e. of Sodus bay	250–400	150
? hill, 1 m. n.w. of Rose	420–600	180
Triangulation station, 2½ m. s. of Clyde	420–600	180
Meridian of Fairhaven		
? hill, 2 m. n.e. of Fairhaven	250–400	150
? hill, 4 m. s.e. of Montezuma	520–700	180
Meridian of Oswego-Weedsport-Auburn		
Triangulation station, 4 m. n.w. of Cato	400–567	167
? hill, 3 m. n. of Cato	440–620	180
? hill, 3 m. w. of Cato	420–600	180
? hill, 4 m. n. of Weedsport	440–620	180
Triangulation station, 2 m. s. of Weedsport	600–740	140
Meridian of Fulton-Jordan-Skaneateles		
? hill, 2 m. s. of Jordan	660–800	140
Cottle hill, 3 m. n.w. of Skaneateles	880-996	116
Region of Syracuse		
? hill, 3 m. n.w. of Camillus	700–860	160
? hill, 2 m. n.e. of Camillus	640–760	120
Triangulation station, 3 m. e. of Camillus	660–799	140
Triangulation station, 3 m. e. of Camillus	580–736	156
? hill, 3 m. s.e. of Syracuse	660–805	145

---

[1] It is a singular coincidence that the celebrated drumlin, the "Mormon hill" [pl. 29, 30], in which Joseph Smith claimed to have found the golden plates of the *Book of Mormon*, should have as its altitude the centennial multiple of the sacred number seven, in English feet. The hight of the hill was not known until the recent topographic survey, but the Latter Day Saints may claim that their prophet had inspired knowledge or divine guidance.

It will be noted that only two drumlins in the above table lift their summits 200 feet above their platform, though several approach that hight.

The length of the drumlins is quite as variable as their hight, but it can not be well determined from the map contours, as a relief of less than 20 feet may carry a distinct ridge for a long distance. The long ridges of drumlinized drift which specially characterize the drift surface in the northwest corner of the State, including the Niagara-Genesee prairie, are almost unrecognized by the topographic map.

Scores of drumlins can be found on the map with a contoured length of a mile, or even a mile and a quarter. A length of 1½ miles is not rare, but 2 miles is extreme. Perhaps the longest well contoured forms are in the Oswego district, shown in plate 6.

The very long drumlins are sometimes produced by the close welding of overlapping ridges.

Composition and structure

The material composing the New York drumlins is very compact till. The writer recollects only one or two instances in which water-laid drift has been found unequivocally incorporated in the drumlin mass. Gravel and sand are frequently found on the flanks of the drumlins, specially where they were exposed to wave work of the glacial lakes, but the experienced observer could never mistake this for drumlin material. Water-laid drift may be expected on the surface of the drumlins as an occasional product of superficial stream work at or near the ice border. In morainal areas the marginal drift, kame or till, may be scattered on and among the drumlins, and sometimes in such abundance as to obscure or perhaps partially bury the drumlin forms. Such a case is found in the Junius kame moraine, midway between Geneva and Lyons. However, this superficial morainal drift must not be mistaken for nor confused with the drumlin material, as it is not only emphatically distinct in its genesis from the subglacial drumlin mass but subsequent in time of deposition.

Only two instances have been found by the writer of water-laid drift distinctly within the drumlin mass. In the northeast edge of the village of Lyons, on Phelps st., a small drumlinlike ridge of till about 500 feet long and 150 feet wide, lying on the east flank of a

larger drumlin ridge, has 15 feet depth of till over a base of sand; but the sand substratum is restricted to the small ridge.

In a recent extensive examination of the internal structure of drumlins, to be described below, a bed of sand was found in the interior mass of a drumlin, situated 2 miles northeast of Fairhaven bay and south of Juniper pond. The waves of Lake Ontario have dissected the drumlin obliquely, exposing a section of till about 100 feet high. About midway in the hight of the cliff is an irregular layer of sand, 2 to 3 feet thick and of considerable but indefinite extent. The sand shows no clear bedding and seems to have been crushed and worked over by the ice rubbing. The extreme rarity of such inclusions of water-laid drift in the drumlins of New York is a conclusive argument against the theory that they are erosional forms, produced by overriding and reshaping of terminal moraines. This point will be discussed later.

The drumlin till, specially in the deeper layers, is decidedly more compact and harder than the ordinary sheet till, and the included stones of all sizes are more generally abraded. The material gives evidence of movement under pressure; it is emphatically the glacial grist.

The proportion of crystalline and far-brought material is apparently less than in terminal moraine deposits, but examination has not been sufficiently thorough to indicate percentages. In any belt it will probably be found that the proportion of material derived from the subjacent strata or the rocks immediately northward is larger in the drumlins than in the moraines. In other words, drumlins represent, at least in central New York, the subglacial or "ground moraine" drift.

Rocdrumlins. Between Palmyra and Syracuse the foundation of the drumlins is Salina shale, mostly the soft red and green beds called Vernon shales. All the deeper valleys are cut in this shale, which may be seen on the slopes as bare patches of bright colors, red and light green. An excellent exposure may be seen at the "blue cut" on the south side of the West Shore and the New York Central Railroads midway between Newark and Lyons; and at the time of this writing (September 1905) the electric road building in that district is making many exposures. At the "blue cut" the Vernon reaches 60 feet above the railroad, or to the hight of about 480 feet, judging from the map contours. In the region of

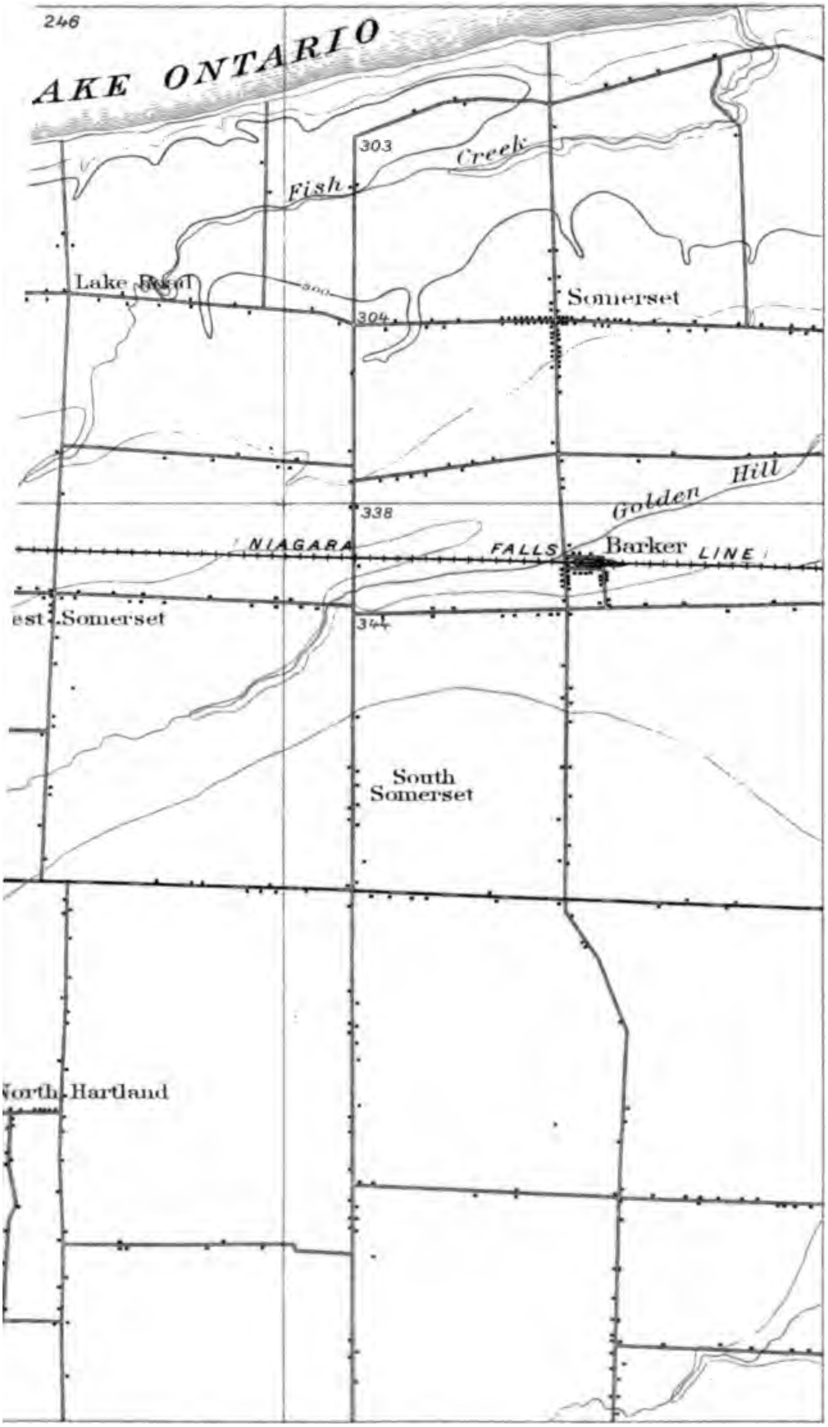
Jordan and Memphis these shales forming the walls and bottom of the broad valley are eroded into forms simulating morainal topography. (This resemblance of the shale erosion forms to moraines is very pronounced all the way east to Oneida, and even the experienced geologist who is new to the region will make wrong diagnosis if he decides by the forms as seen from a distance.)

In the Jordan-Memphis district the Vernon shales reach up over 500 feet, while the lake and stream fillings in the valleys are about 400 feet altitude. The Vernon shales, therefore, extend upward about 100 feet above the lowlands and are overlain by the somewhat harder but yet soft gypsum-bearing Camillus shales. East of Jordan they form the common platform from which the drumlins rise [pl. 9, 10]. But west of Jordan, as far at least as Newark, the drumlins are situated much lower, their bases being contoured [pl. 11, 12] by the 400 or 420 foot contour, and many rising out of the Montezuma marshes as if partly buried under lake deposits. It appears, therefore, that in the Weedsport-Lyons belt the Vernon and Camillus shales belong in the same horizontal plane or topographic horizon as the drumlins, and the interesting and important question arises if the drumlin forms may not be partly shale instead of till. Some study of this problem has been made with definite results. The drumlins show only till at the surface, in nearly all cases. Often this may be only a veneer or varnish of drift rubbed into the soft shale. The West Shore Railroad has several good cuttings through drumlins in the stretch west of Port Byron which ought to reveal interior composition and structure, but the cut slopes are so coated with wash from the upper material that to casual inspection they appear as till.

One and one half miles northeast of Port Byron the red Vernon shales appear clearly on the slopes and at the summit of a drumlin-shaped hill having a summit contour of 460 feet. This hill is indicated in the lower left hand corner of plate 11. Here we certainly have a drumlin form in rock, a rockdrumlin. It is very likely that other of the lower drumlin forms may be chiefly shale with only a veneer of drift, and it is more than likely that some of the larger drumlins have a base or core of shale.

All the western central New York rocks have a decided southerly dip. It is evident, therefore, that north of the Syracuse-Lyons parallel the strata should lie at increasingly higher elevation.

TION DEPARTMENT UNIVERSITY OF THE STATE OF W YORK
N M. CLARKE
TE GEOLOGIST STATE MUSEUM BULLETIN 111 PLATE 19



IT OF OLCOTT QUADRANGLE. H.L.Fairchild 1905

DRUMLINIZED SURFACE

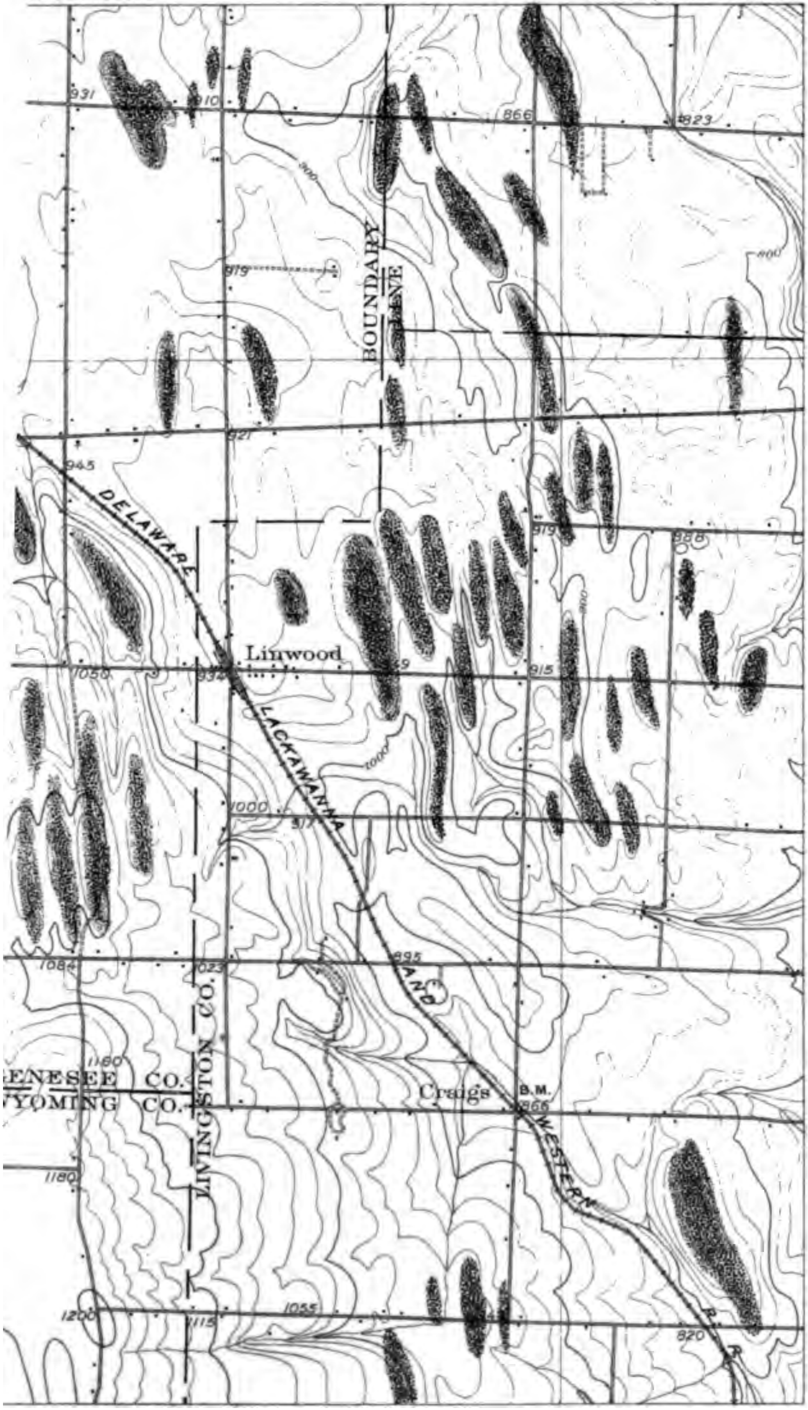
Near the west end of the Niagara-Genesee prairie. *Compare plate* 18. The ice-molding carries the streams oblique to the slope. Surface smoothed by Iroquois waters.

ION DEPARTMENT
M. CLARKE
E GEOLOGIST

UNIVERSITY OF THE STATE OF NEW YORK

STATE MUSEUM

BULLETIN 111 PLATE 20



OF CALEDONIA QUADRANGLE.

GENESEE VALLEY DRUMLINS

H.L.Fairchild 1905

The attitude of the drumlins shows how the later ice flow in the Genesee valley was diverted from the general southwest direction. Not all the drumlins are indicated.

The vertical or stratigraphical range of the Vernon shales, which are several hundred feet in thickness (the thickness of the whole group of Salina shales is about 1400 feet, *see* page 404) would include the whole hight of all the drumlin forms in a considerable belt of territory. An examination was made of the hills west of Baldwinsville with a result not unexpected. It was found that all the drumlin forms are clearly composed of red shale, with only an apology of till covering. All the hills in the upper half of the map, plate 10, and lying between the two north-leading valleys are known to be not drumlins but rocdrumlins.

At first sight these hills would be regarded without question as true drumlins, but there are decided though refined differences which appear on closer study. The rocdrumlins are not so symmetrical as the till forms; the slopes are less regular; and the struck ends are liable to be more abrupt and irregular and with less convexity. The differences are clear when once recognized, and are fundamental. The 20 foot contours of the map even reveal a difference. Looking at plate 10 it will be noted that the bases of the hills are indefinite, and that as hills they do not possess the strong individuality of the drumlins, as shown in plates 11 and 16, for example.

These Vernon shales are only hardened clays, without structure and very easily decomposed.[1] They yield more readily to weathering and probably to erosion than any other rock, and the product of the ice rubbing was doubtless a lubricant and plastic paste essentially like clayey till in its mechanical properties. In consequence the hills of Vernon shale which stood within the zone of drumlin formation, in the conflict with the moving ice, were more easily shaped into the drumlin form than other rocks, but when given that shape they resisted the ice impact better than harder rocks. These shale hills were at the same time more compliant and more resistant. They became drumlins in effect though not in origin. They are erosional forms, while drumlins are constructional forms.

The soft Vernon shales extend westward through the State but nowhere appear so prominently at the surface as in the region described above. Eight miles south of Rochester they are exposed at about 570 feet altitude. It is apparent that along their east and west outcrop they have been eroded by weathering and ice rubbing and the belt of outcrop deeply covered with drift. Their more common appearance on the Newark-Syracuse parallel is partly due to greater thickness and also to the postglacial excavation by the ice border drainage. The Salina shales as a whole, many hundreds of feet in thickness throughout the drumlin area, have supplied a large amount of plastic and adhesive material for the drumlin construction process, and may be one factor in the production of the drumlins.

---

[1] The rapidity with which these shales weather to mud was the cause of dispute and litigation in the matter of the deepening of the Erie canal a few years since. The contractors justly regarded the shale as "rock" and charged for rock excavation; but inspection a few months later found the spoil banks to be only clay rubbish.

Concentric bedding. If drumlins are constructional forms, that is, were built up by a plastering-on process, then it should be expected that on cross-section they would reveal some concentric bedding or onion structure, with the upper layers parallel to the drumlin surface. Theoretically the bedding need not be conspicuous as there could not have been great variation in the constructive process, as compared with the work of water, in either kind or quality of material or in rate of deposition. The comparative uniformity in the work of the ice, taken in connection with the heterogeneous character of the till, would seem unfavorable to any conspicuous structure.

Few cuttings in drumlins expose large sectional areas, and such as do occur can commonly be seen only at close range, which is unfavorable to inspection of indefinite and large-scale structures. To recognize the general structure it is necessary to have a comprehensive view, yet not so distant as to obscure all details.

Bedded structure in drumlins has been casually noted in a few instances but the only description of such feature (in the writer's knowledge) has been given by Upham, of a few drumlins on the Massachusetts coast at Scituate and in the neighborhood of Boston, which have been dissected by wave erosion.[1]

The most favorable exposure of interior structure of drumlins known to the writer is found along the south shore of Lake Ontario, and specially between Sodus bay and Oswego. In this stretch of about 28 miles not less than a score of drumlins, many of large size, are dissected to their core by the wave erosion. The constant undercutting by the waves [pl. 8, 43-46] yields continually fresh sections from top to bottom, and fortunately in different directions. Some drumlins are cut in direct cross-section; some in oblique

---

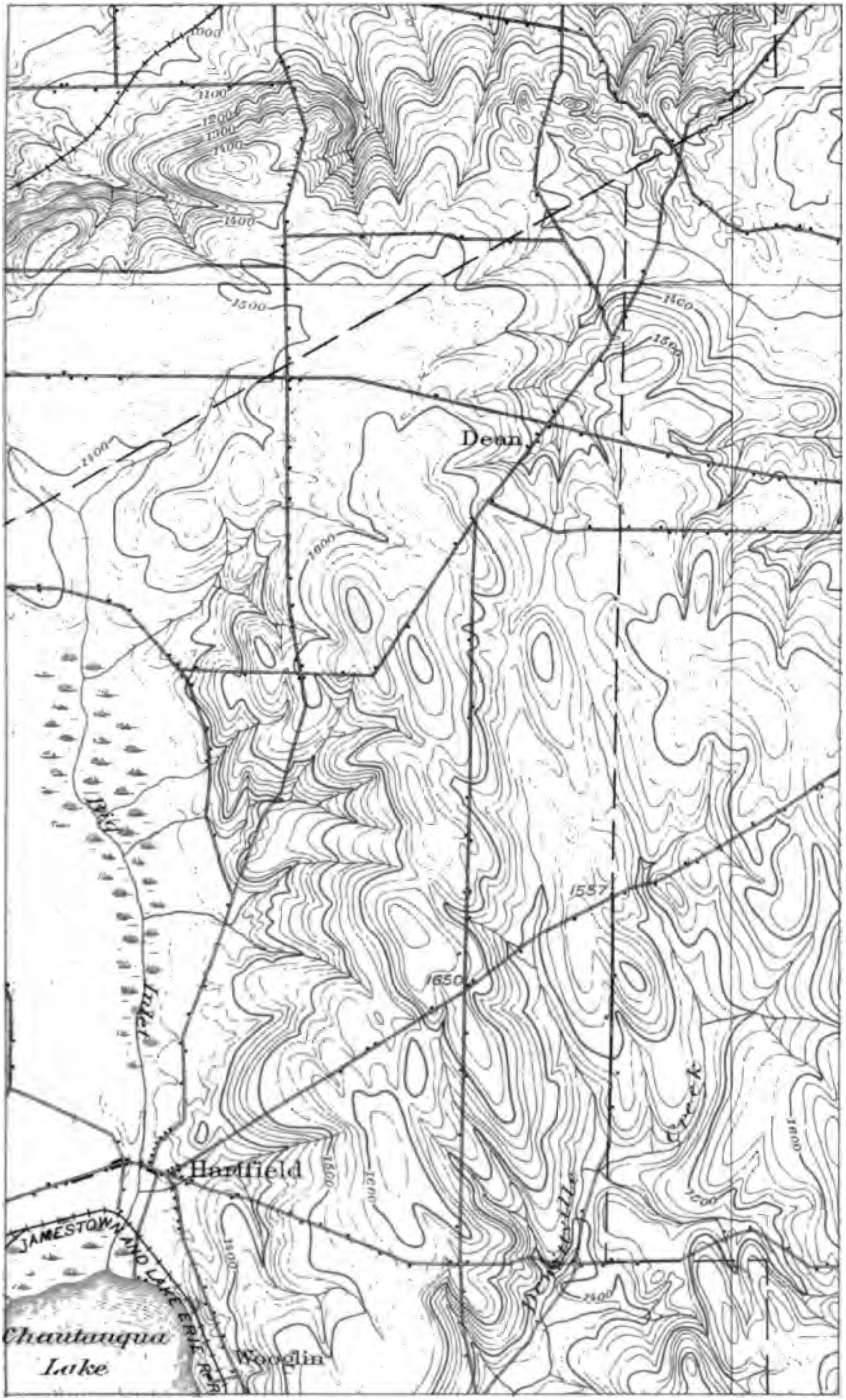
[1] *See* titles on page 438 for the years 1883, 1889 and 1892.

EDUCATION DEPARTMENT
JOHN M. CLARKE
STATE GEOLOGIST

UNIVERSITY OF THE STATE OF NEW YORK

STATE MUSEUM

BULLETIN 111 PLATE 21



PART OF DUNKIRK QUADRANGLE

H.L.Fairchild 1905

CHAUTAUQUA DRUMLINS

This area was molded by southeastward flow of the later ice, spreading from the Erie basin.

section ; and some in longitudinal section. One could not reasonably ask for more favorable exposure than nature here affords.

The structure can not be seen properly at close range from the beach, nor at the long range from the steamers. In August 1905 the writer secured the help of an oarsman and with a small boat examined the entire shore from Sodus bay to Oswego. Part of this stretch was reexamined in September, and the study carried westward from Sodus bay. Many photographs[1] were taken, some of which are produced in plates 43 to 46.

The erosion cliffs range in hight from 20 feet up to 140 feet The growth of vegetation is rarely sufficient to obscure the structure, and in some cases is in itself a proof of the till bedding, as it lies in horizontal lines. The higher cliffs are all bare.

More than half of the cliffs show undoubted concentric bedding and in several it is surprisingly distinct. At distances which minimize the relief of the cliff faces, in buttresses, reentrants, and amphitheaters [pl. 43], the fact of bedding parallel with the drumlin surface is strikingly evident, and is shown in different ways. A difference in the texture of the beds is apparent even at close range. Distinct zones or lines of boulders are often seen. A difference in shade of color is common, and the shading due to varying capacity for moisture is pronounced. The latter is also shown by patches of vegetation clinging along certain zones. The second cliff east of Sodus bay, "Cline's bluff," shows at even 2 miles distance a conspicuous line of vegetation. A most striking proof of bedded structure is shown by the differences in weathering, which are often indicated, as in plate 46, by the uniformity in hight on the cliff face of the conical buttresses. Two other cliffs which show this feature well are: one east of Juniper pond and 2 miles east of Fairhaven bay, which shows three lines of erosion cones; and another a mile northeast of the mouth of Eighteenmile creek and about 5 miles southwest of Oswego.

---

[1] The first photographs were taken with an ordinary shutter which proved too slow with the tossing of the boat. These first photographs show clearly the bedded structure but they are too blurred to be suitable for reproduction. For the second trip the Bausch & Lomb Optical Company kindly loaned a "Plastigmat" lens and a "Volute" shutter, and the photographs of plates 43 to 46 represent an exposure of 1-150 of a second, in the hazy light of the last day of September. The camera was a 5x7 Cartridge kodak, the only camera which the writer has used in six years.

When these views were taken the drumlin sections were very dry and the hygroscopic differences in the till layers did not show as well as they do soon after a heavy rain. Much better views can be obtained when all conditions are favorable, as quiet water of the lake, good lighting and the cliff faces in best condition.

To Mr W. R. Walsh of Sodus Point the writer's thanks are due for valuable assistance.

In cross-section view the concentric bedding decreases in convexity passing downward toward the bottom of the drumlin. In other words, the bedding near the base of the drumlin is quite horizontal or slightly arched; and the arching increases with hight until near the top the layers are parallel with the drumlin profile. In some instances, particularly toward Oswego, the sections exhibit a superficial bed, estimated at 10 to 20 feet thick, of a lighter color and yellowish shade, and apparently less compact than the deeper blue-gray till. This superficial bed weathers into smoother or more uniform faces, instead of the projections, pinnacles, towers, or battlemented forms of the deeper and harder till.

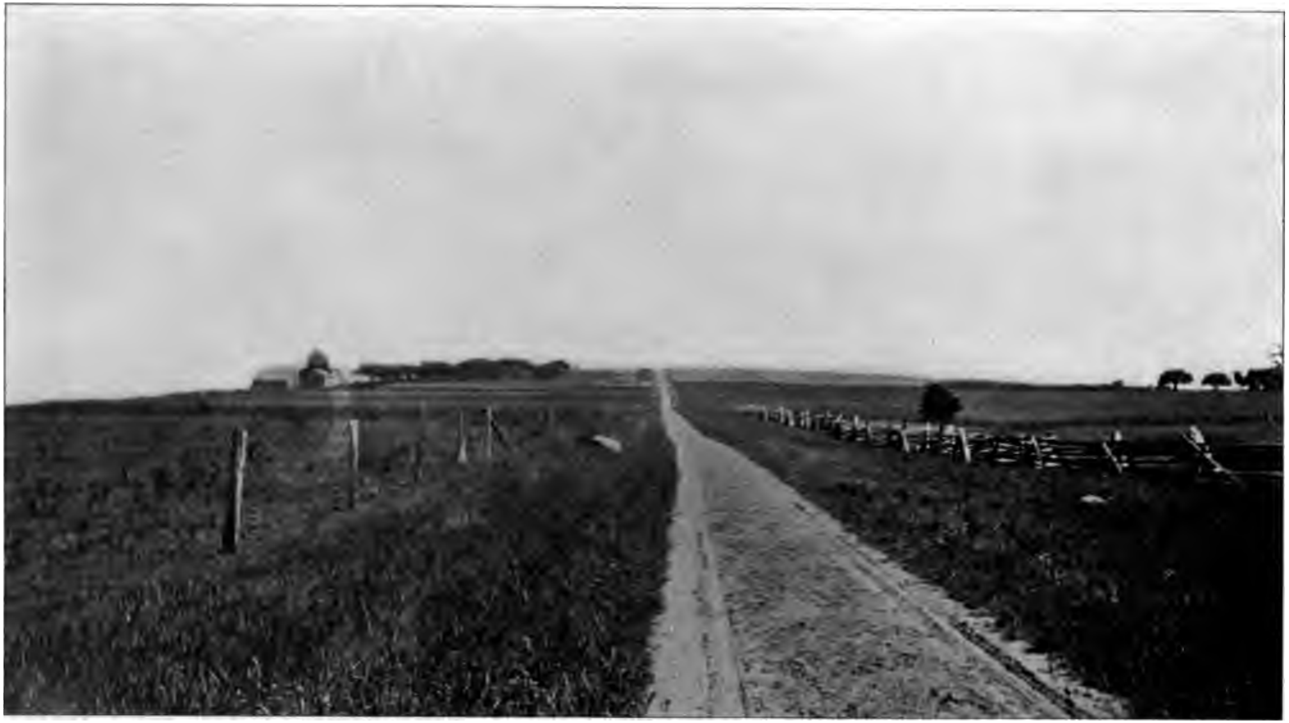
A good test, and a confirmation, of the concentric structure is found in the oblique and the nearly longitudinal sections. A glance at plates 7 and 8 will show how the lake erosion is cutting the drumlins at very different angles. It is found that the stratification exposed in these different sections has the direction which would correspond to a concentric bedding. In sections approaching the longitudinal the bedding is quite straight and declines parallel with the crest of the drumlin toward the tail of the hill. In general the upper beds are parallel with the cliff profile and have the curvature appropriate to the angle of the section.

The application of these facts of drumlin structure to the problem of drumlin origin will be found in a later chapter. To facilitate the study of the subject by any one who wishes to examine the drumlin sections for himself the following notes and directions are supplied.

West of Sodus bay (the Pultneyville sheet) the cliffs are partly morainal and only two good drumlin sections occur, one of them being shown in plate 46. East of Sodus bay the lake shore is included in the Sodus bay sheet, reproduced in plate 8, and the Oswego sheet, partly shown in plate 7. These maps show approximately the angle of the wave cutting with reference to the drumlin axes.

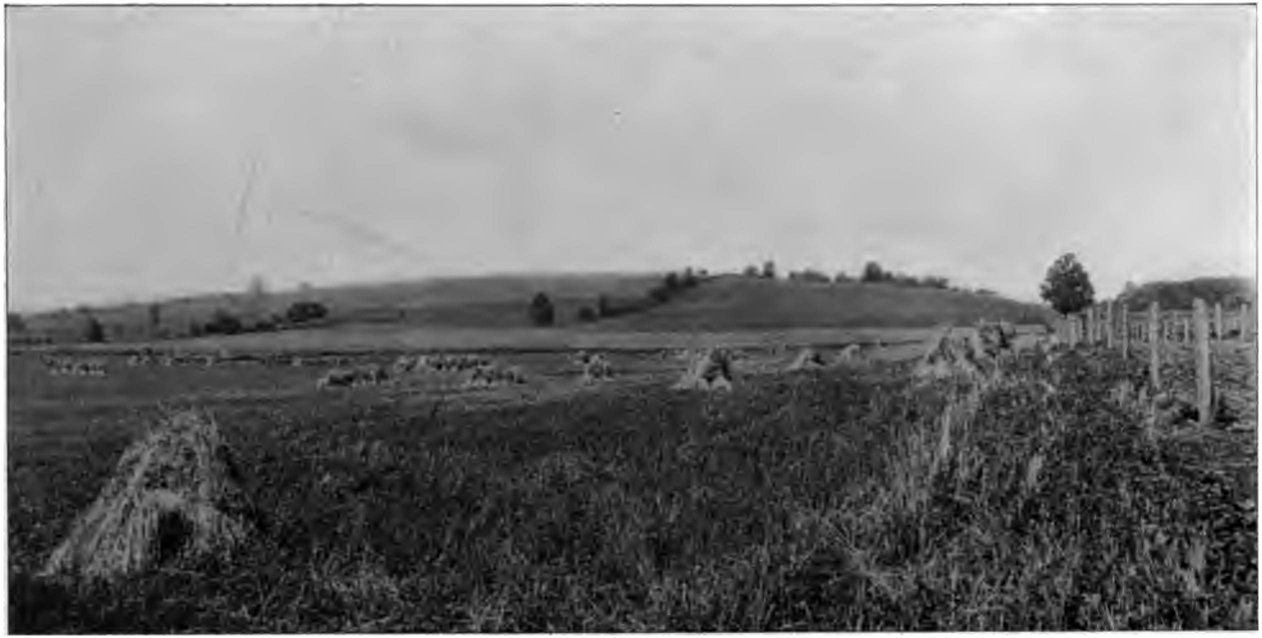
The drumlins which display the bedded structure in the clearest manner are, taken in order eastward: Lake bluff (using the local names) [pl. 44]; Cline's bluff, 1 mile east of Lake bluff; Blind Bay bluff, 1½ miles east of East bay [pl. 45]; two cliffs either side of Juniper pond, which lies 2 miles beyond Fairhaven bay; and the

Plate 22



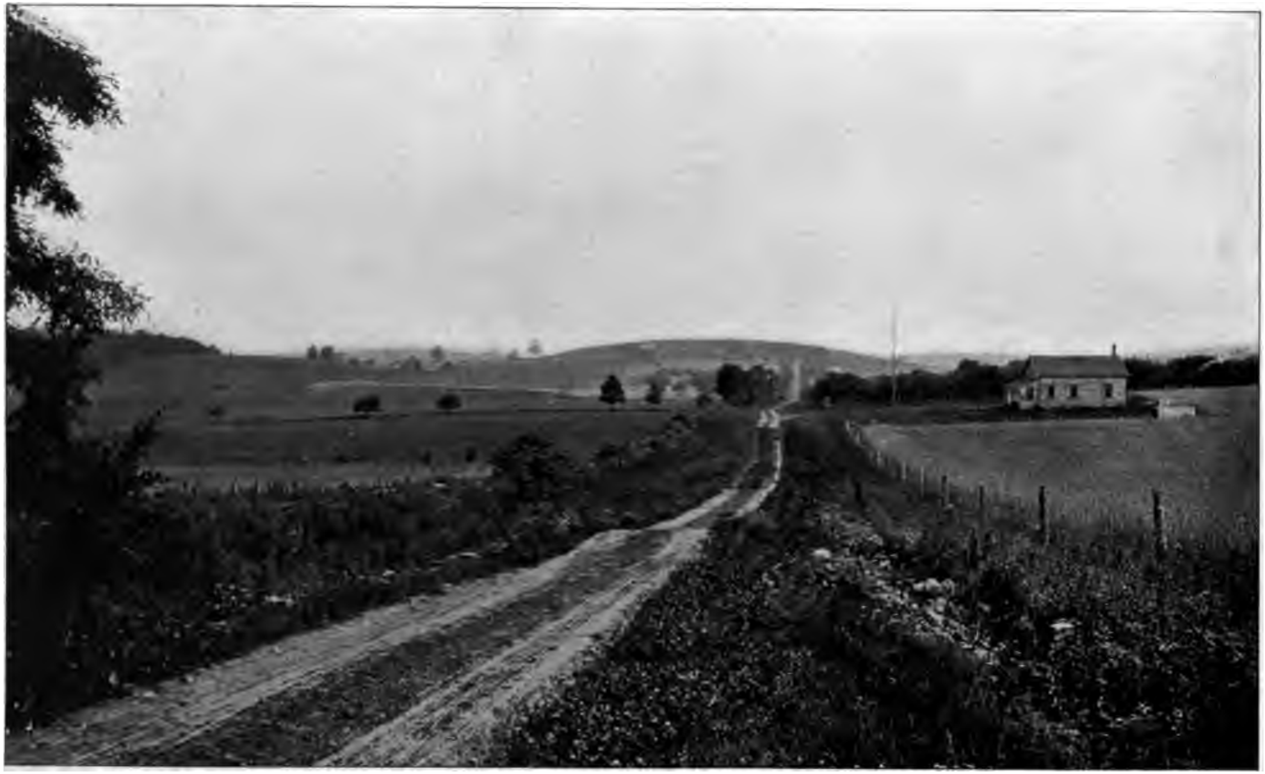
Drumlin 1 mile west of Lily Dale. View looking east

Plate 23



Drumlin 1 mile south of Lincoln, Wayne co. View looking south of west

Plate 24



Wayne county drumlins, town of Walworth. Looking west from Freeville hill

two cliffs midway between Eighteenmile and Rice creeks, southwest of Oswego.

The best longitudinal sections are the one east of Juniper pond and the one halfway between Eighteenmile and Rice creeks. The lighter colored top layer is well shown in the three cliffs east of Port bay.

It should be understood that the distinctness of the bedding varies with the degree of moisture and the lighting; and that it may be subject to change with depth of cutting and so vary with time.

Formation: theoretical mechanics

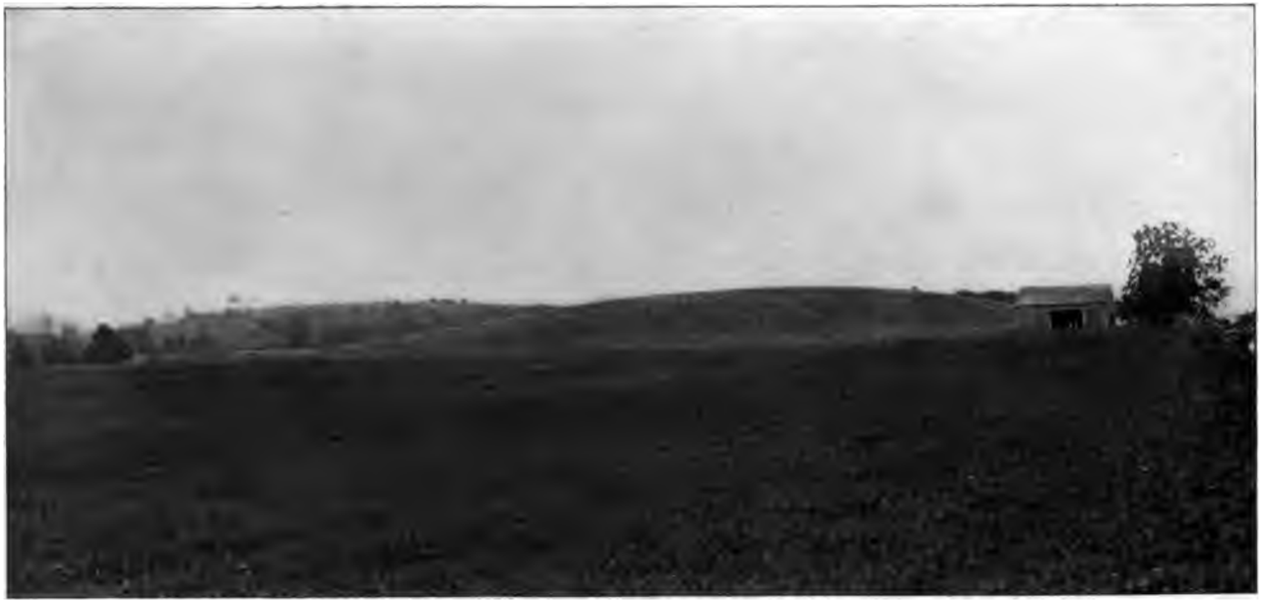
Thus far this writing has been of a descriptive character with only a modicum of reasonable inference. It is now time to take up the philosophical side of the study and if possible explain the origin and manner of making of the drumlins. In the earlier writings on these structures the question of their genesis naturally received much attention, but without confident conclusions. Probably no geologist doubts their glacial genesis but the precise manner of their formation has been in question. Two general views have been held, one that they are overridden and reshaped moraine drift, the other that they are constructional forms, built up ab initio by the moving ice out of its ground moraine or interglacial drift. That they received their form by the molding effect of the overriding ice sheet seems too evident to be questioned.

The idea that drumlins were primarily moraine masses may be true of some drumlins, and possibly of some forms in New York; but it certainly does not apply to them in general. The distribution of the drumlins is not in accord with the theoretical location of any former morainal belts; and this conception takes no account of isolated drumlins in some regions, or groups of drumlins far removed from suggestions of other drift masses. Moraine deposits are expected to lie in continuous belts. Furthermore, no moraines of such breadth and quantity of drift as are held in the Rochester-Syracuse drumlin area are found in New York, probably not in the Eastern States.[1]

---

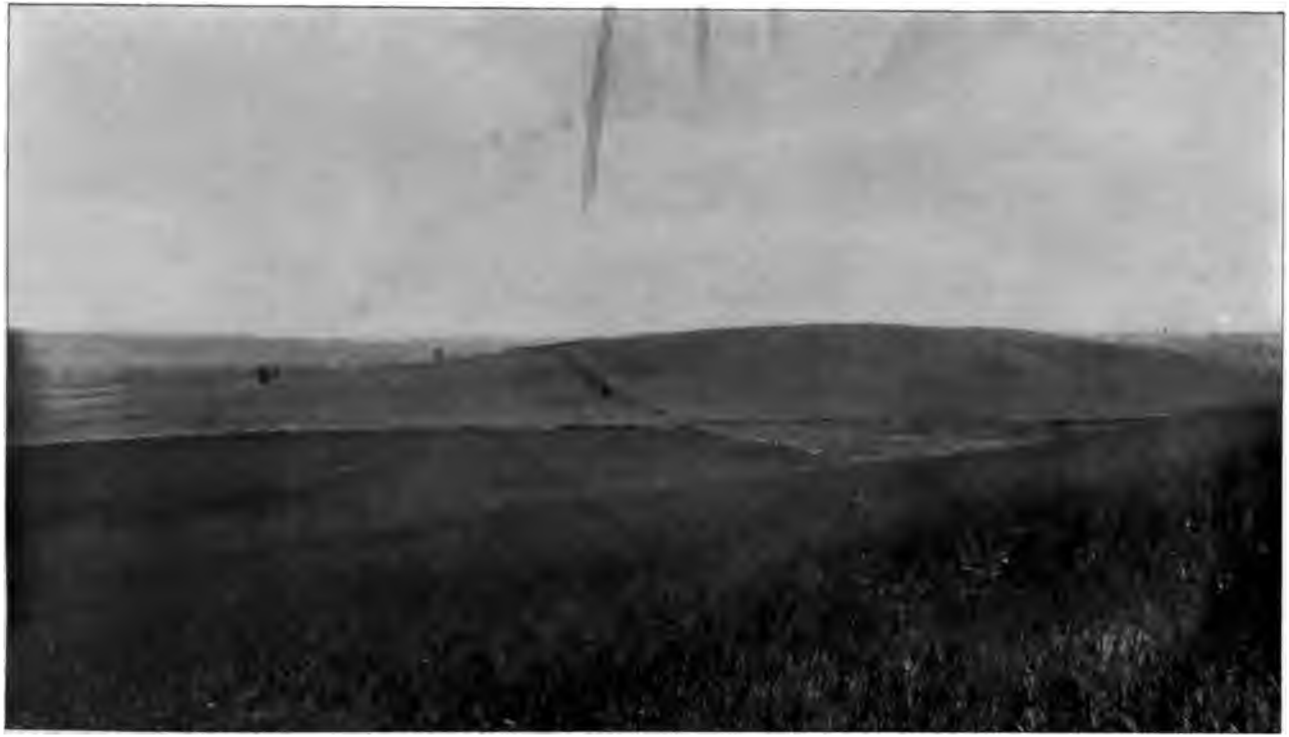
[1] It should be admitted that the full history of the ice work in New York and New England is doubtless more complex than we now realize, and that probably there was ice invasion with its attendant frontal waters previous to the Wisconsin epoch. We now see the deposits as the last ice sheet left them, and while we must take the phenomena as we find them and study them as they lie we must not ignore the probability of an antecedent and different condition. However, it would be unscientific to minimize the facts before us and magnify the unknown or theoretical features.

Plate 25



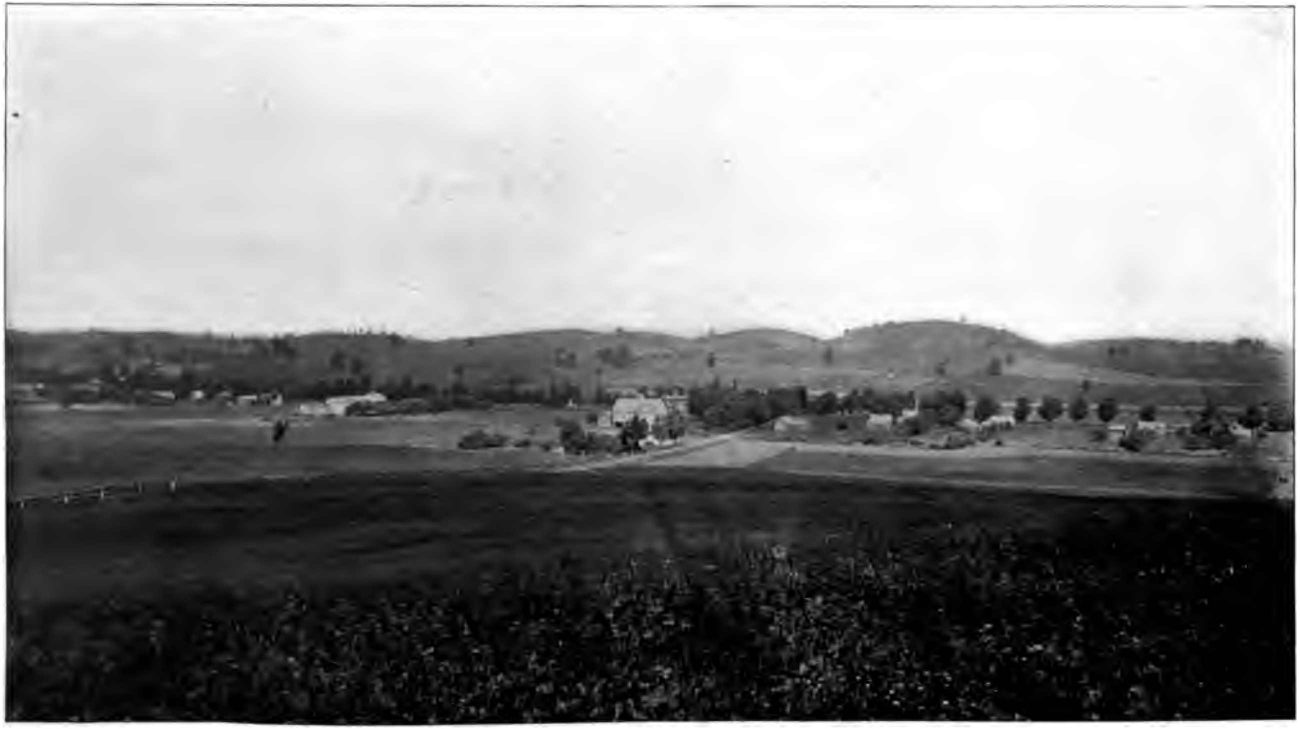
Wayne county drumlins. 3 miles north of Walworth. Looking east of south

Plate 26



Drumlin 1 mile east of Elbridge. Looking south of east. Same point of view as in plate 27

Plate 27



Drumlins north of Elbridge. Endwise view. Looking west of north. Same point of view as in plate 26

ground or on an up slope (as in the New York drumlin area) was mainly an effect of the vertical pressure in the deeper and rearward part of the mass. The depth of the ice sheet along the drumlin-making zone was probably insufficient to greatly aid the forward movement; but to the degree that plasticity was effective the vertical pressure might have had some effect in modifying the movement or in producing differential flow.

3 *Vigor and velocity of flow.* This is due primarily to the thrust from the direction of the deeper ice. The horizontal displacement or mass movement of the ice would be influenced by the larger features of the land surface and by the local temperature and rainfall [see *c*].

4 *Differential flow.* The practical plasticity of the ice would theoretically seem to allow unequal flow, or a tendency to flow in prisms or currents analogous to stream currents; and the drumlins are evidence of such local variations in the ice work.

5 *Plasticity.* This property of glacier ice would probably be increased by pressure, heat and water supply as a lubricant. In the marginal, drumlin-forming zone of the ice sheet plasticity due to vertical pressure would be reduced, that due to horizontal pressure would be fairly constant, while that due to heat and rainfall perhaps would be increased.

b Factors relating to the drift held in the ice

1 *Volume of the drift.* It has been recognized that plastic flow of glacier ice diminishes with increase of rock debris. But the movement of the lower ice by rearward thrust would not be so greatly affected by the contained drift. The influence of the drift toward rigidity might assist in producing differential flow in prisms or bolts. Whatever might be the effects on the flow of the ice by variation in the load of drift its abundance in the lower ice would seem to be a direct aid to drumlin building.

2 *Position of the drift.* The vertical location of the rock rubbish in the ice seems an important factor. Debris superficial to the ice sheet could only produce morainal masses. Drumlins must have been built from the debris carried in the lower layers of the ice.

3 *Quality of the drift.* It would appear that a clayey, adhesive character of the drift would facilitate the plastering on process, by which the New York drumlins are certainly made. No drumlins are found composed largely of boulders and friable material.

c Factors of external control

1 *General land slope.* A down slope would favor movement of the ice both by thrust and by plastic flow of the upper over the lower layers. An up slope would probably retard or prohibit motion at the bottom except by thrust. The great drumlin area of New York has an up slope, but the dominant minor area is nearly level. The Chautauqua drumlins are on high ground, very irregular but broadly level.

2 *Minor topography.* This factor is indefinite and uncertain because variable in many ways. It would seem that great irregularity of the overridden land surface would be unfavorable to movement of the lower ice, and the drumlin-making motion would lie more in the plane of the hilltops. (This has a bearing on the construction of the Syracuse island masses, page 425.) Small prominences in the bed of the ice sheet might be favorable as nuclei for the initiation of drumlins.

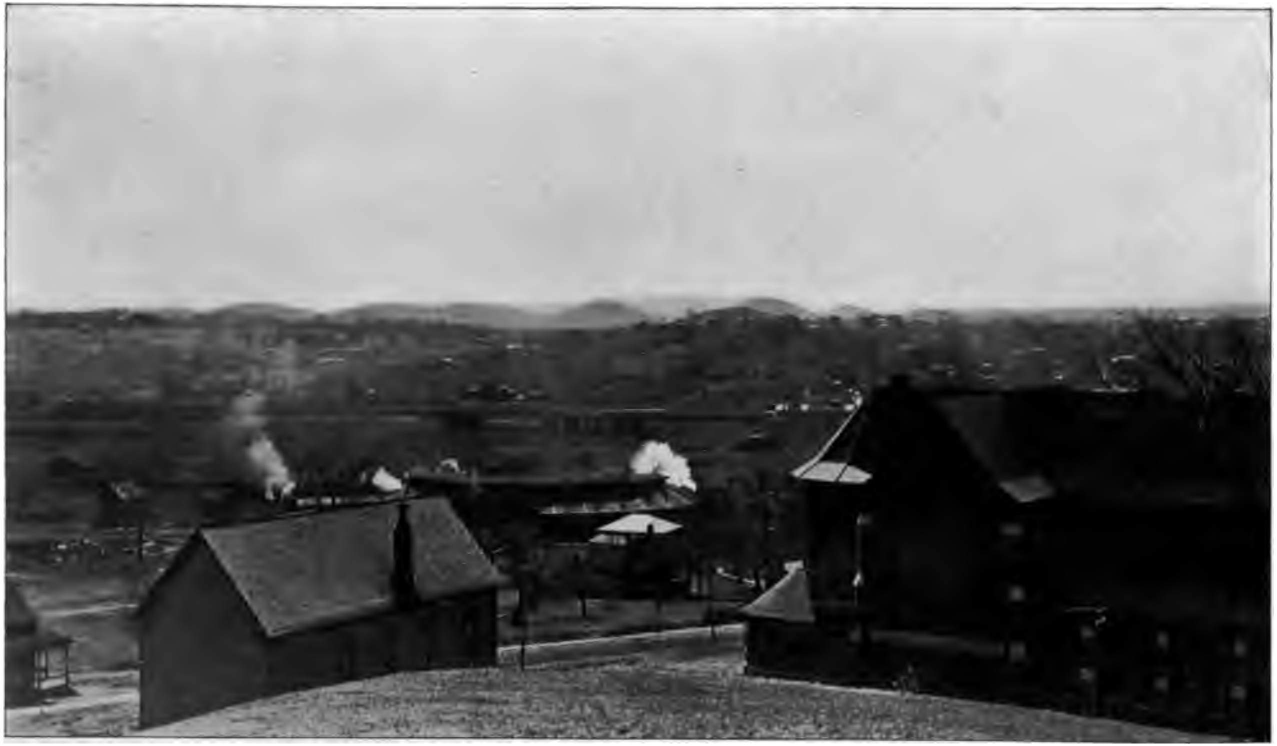
3 *Temperature and water supply.* Plasticity of the ice would be favored by heat and water. Cold and dryness favor rigidity. The margin of the ice sheet must have had nearly the highest possible temperature and the largest supply of lubricating water, from rainfall and ice melting. This would be quite independent of latitude as the ice can not be warmed above the melting point.

It is apparent that the drumlin-building process involves many factors, and most of them indeterminate. The problem is exceedingly complicated, including not only the difficult subject of the behavior of plastic solids but the action of the plastic ice under a complexity of geologic conditions.

Drumlin forms and observed relations. The interaction of the physical and geologic factors noted above has produced a great variety of drift forms which we may include under the general class of *ice-molded*, or *drumlinized drift*. These forms have been described or noted in the writing above, but it is well to name them here for comparison.

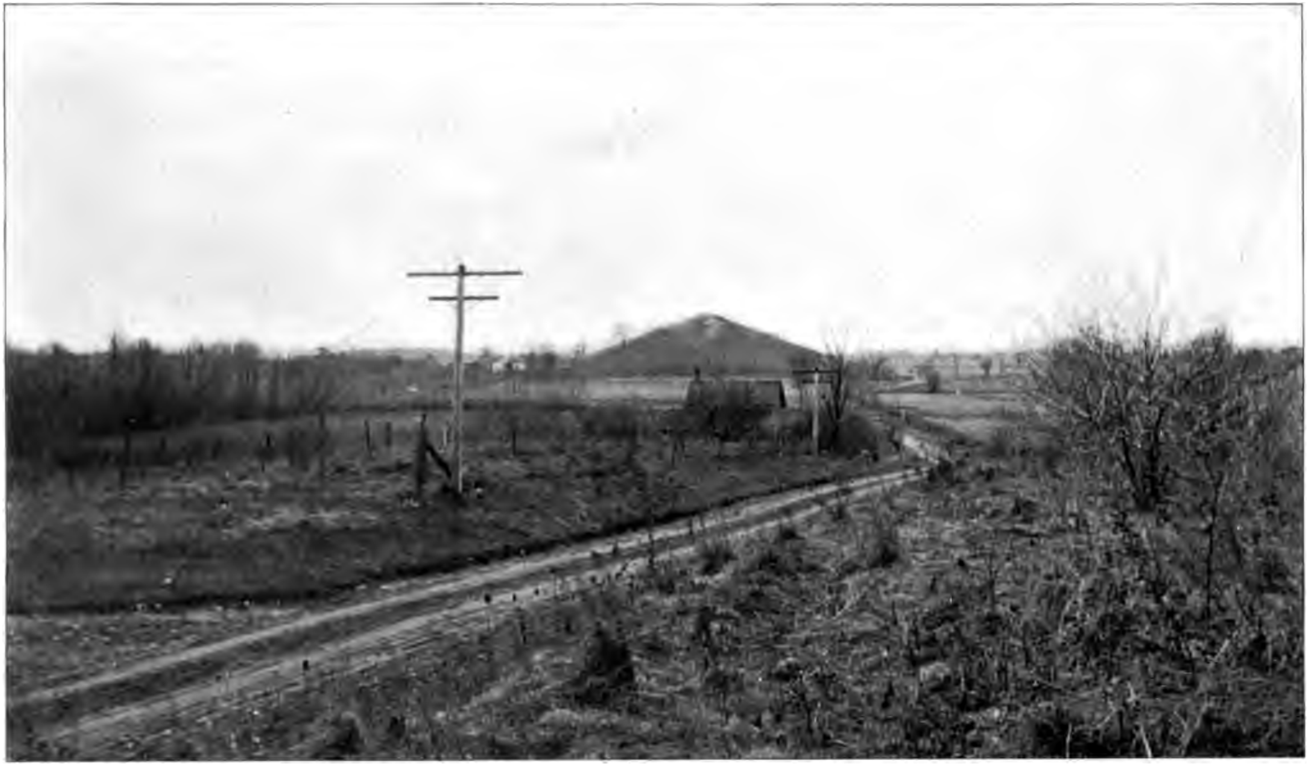
1 Domes or mammillary hills and low broad mounds.
2 Broad oval drumlins [pl. 7].
3 Oval drumlins of high relief [pl. 11].
4 Long oval drumlins, commonly bolder on the north or struck end; the dolphinback or whaleback hills [pl. 14].
5 Short ridge drumlins [pl. 6].

Plate 28



Endwise view of drumlins 3 miles southeast of Syracuse. Looking east of south from St Vincent de Paul Church, Syracuse. These drumlins are the southeast extremity of the drumlin area.

Plate 29



Mormon hill. Drumlin 4 miles south of Palmyra. End view looking south. Compare plate 30

Plate 30

[illegible]

6 Long ridge drumlins. This includes two extreme varieties of form: (*a*) the long broad ridges or rolls or gentle swells which are not generally recognized as belonging in the drumlin class, and commonly fail of representation on the contoured maps [pl. 18]; (*b*) the small, close-set, parallel ridges which lie as minor moldings between the larger and conspicuous ridge drumlins, or those which form the attenuated edge of a drumlin belt [pl. 13].

7 Abrupt struck slopes [pl. 30, 35, 40].

8 Low or gentle struck slopes [pl. 22, 23].

9 Sharp crested hills with steep, or even concave, side slopes [pl. 29.]

Many occasional or peculiar forms and characters might be noted but they are not regarded as genetically important.

The relationships of the several forms are not so definite or exclusive as might be expected, though further study may discover new facts. However, there are certain broad relations of distribution and association which will be restated here.

1 The drumlin area is practically restricted to the north-facing or ice-opposing slope.

2 The region of greatest development of drumlins is on the low Ontario plain, which is nearly level.

3 The greatest development lies over the greatest thickness of the Salina shales, or where the drift is most clayey and adhesive.

4 The predominant drumlin area lies where the ice flow was east of south and at a high angle with the general southwesterly flow.

5 The somewhat exclusive development of the long and low ridges (6 *a*) is in the northwest corner of the State where the ice had only the one direction (southwest) of flow, but where there was less volume of clayey drift because less thickness of eroded shales.

6 The individual drumlins are not placed in any orderly sequence or regular disposition, but are irregularly spaced.

7 Within the same belt of drumlins or what is regarded as a formational unit the south forms or those nearer the ice border are more attenuated, while the north forms or those under the deeper ice are broader.

8 A belt of moraine drift lies in front of the attenuated border of the drumlin belt.

9 The greater hight of the drumlins, their steepness of slope and

regularity of form seem to occur in the middle of the belt and to characterize the maximum work of the constructive process.

10 Steep struck slopes seem to be more commonly associated with the steep and long ridges; while the low struck slopes pertain to the lower and broader forms.

Relation to moraines

The precise relation of the several drumlin belts to the terminal (recessional) moraines can not be fully stated until further careful study has been given to the moraines, but a few interesting facts can now be given.

If the drumlins specially represent the more vigorous movement of the bottom ice during episodes of either frontal advance or halts in the frontal recession then each drumlin belt should correlate with a frontal moraine.[1] Such relationship seems definite for the central or main drumlin belt, the Oakfield-Syracuse series, in the stretch from Syracuse westward as far as the meridian of Rochester. Where the drumlins fade out to the attenuated forms, from Auburn westward to Geneva, a distinct moraine lies 2 or 3 miles in front, on the south [pl. 13]. Remnants of the moraine mark its course eastward to Split Rock, southwest of Syracuse, but in the Split Rock district the ice front was swept by rivers of ice border drainage and the ice-rafted drift was largely dropped into the grasp of the streams. West of Geneva the same relation of drainage to the ice front is very pronounced. A remarkable series of strong river-cut channels extending from northwest of Batavia eastward to Phelps swept the ice margin and removed most of the terminal drift, though some remnants are left, sufficient to prove its position.[2]

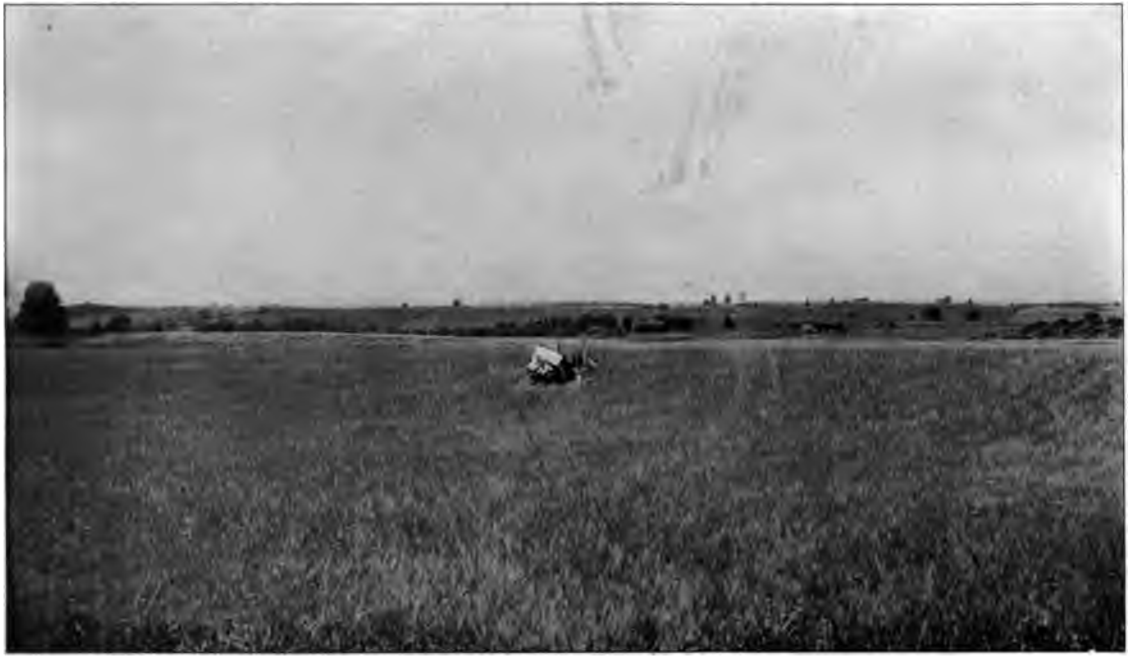
The interesting fact in this connection is that the drumlins of the main series reach in full strength up to the north bank of these channels [pl. 9, 11, 14] and there abruptly end. The drainage channels do not represent the forward position to which the ice would have reached with no interference (or the location of the moraine

---

[1] The theory is now held by glacialists that the front of the continental glacier receded by oscillation, a succession of retreats and lesser readvances, and that the stronger moraines were accumulated at the ice margin during the culmination of the readvances. The successive moraines in any given area are thus supposed to mark the successive readvanced positions of the ice front. For this subject see specially the writings of F. B. Taylor, "Moraines of Recession and Their Significance in Glacial Theory." Jour. Geol. [illegible].

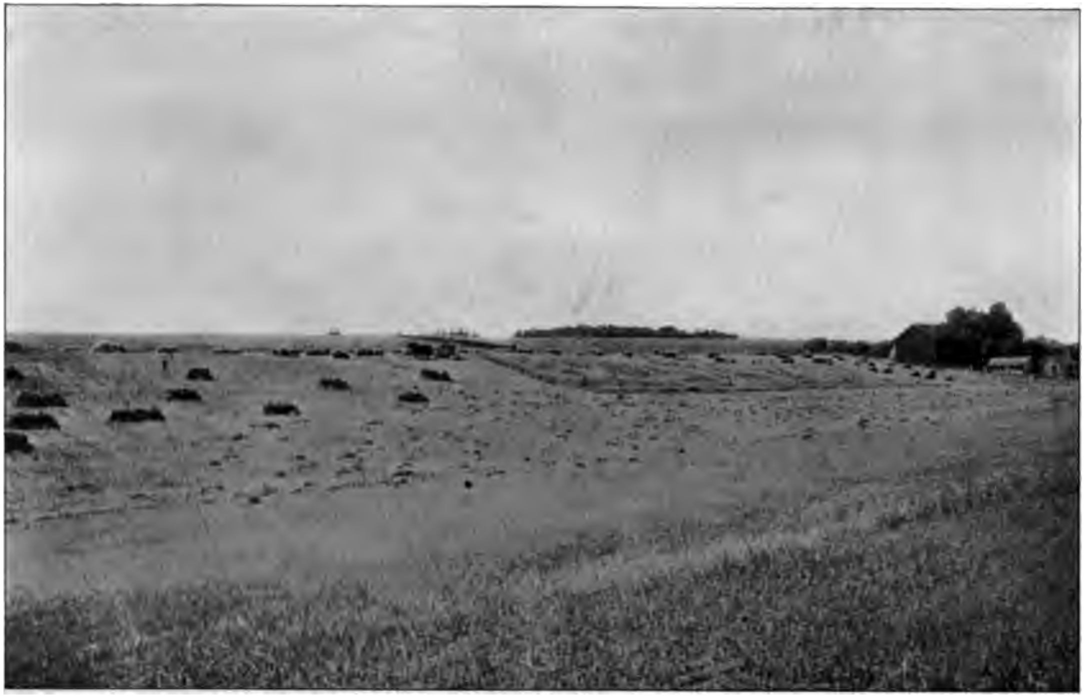
[2] The description of these glacial river channels will be found in another bulletin of the State Museum, under the title, "Glacial Drainage between Batavia and Syracuse."

Plate 31



Drumlin profiles blending in smooth horizon line. Looking southwest from 1¼ miles southwest of Wayne Center. At least 12 drumlins in the view

Plate 32



Ridge drumlins 4 miles southeast of Clyde. Looking northwest from north and south road, 1 mile north of county line. Land of W. H. Lawrence. Three ridges lie in the background

Plate 33

in such case) but a belt further iceward, the rivers truncating the thinner border of the ice sheet.

Moraine belts like the Auburn and Seneca Falls moraine represent only the superglacial and higher englacial drift, carried to and passively dropped at the extreme margin, while, pari passu, the drumlins were forming beneath the ice in the rear of the moraine, from the subglacial (and perhaps the lower englacial) drift.

When recession of the ice front again occurred, either by increased melting or by diminished ice movement, the superior drift was quietly lowered on the drumlin territory, falling chiefly in the hollows between them. Not infrequently we find a patch of irregular surface among the drumlins which can readily be discriminated and mapped as moraine, and rarely this may obscure the half buried drumlins [*see* p. 412] as in the Junius kame area. Sometimes the volume of moraine drift increases to the north and is so distributed as to give a decided morainal surface among the northern drumlins, as in the Walworth district [pl. 15]; or else the next succeeding moraine on the north laps on to the north edge of the drumlin belt, as in the Oswego district [pl. 6].

At the termination of heavy lines of glacial drainage, during both the active and the stagnant episodes, heavy deposits of water-laid drift (kame moraines) accumulated, as the Junius, Victor, Irondequoit valley, Mendon, and other kame areas.

Theoretically the moraines should be weak where the drift was left in drumlin form, and the facts seem in accord. In the stretch from Batavia to Syracuse the moraine belts are weak, though a few kame areas are strong.

Special features

Syracuse island masses. These remarkable groups are partly shown in plates 9 and 10 and are fully shown on the Syracuse and Baldwinsville sheets. They are partly bounded by river channels of the latest glacial drainage cut in Salina shales. North of Warners [pl. 9] is an example of such drumlin massing not surrounded by river valleys. In the more striking of these groups there is a cumulation or increase of hight toward the center which is a peculiar feature. If these drumlin masses have a core of rock reaching above the Salina shales, which form their base up to 500 feet or more, it has not been found, though it is not improbable for the more northerly groups.

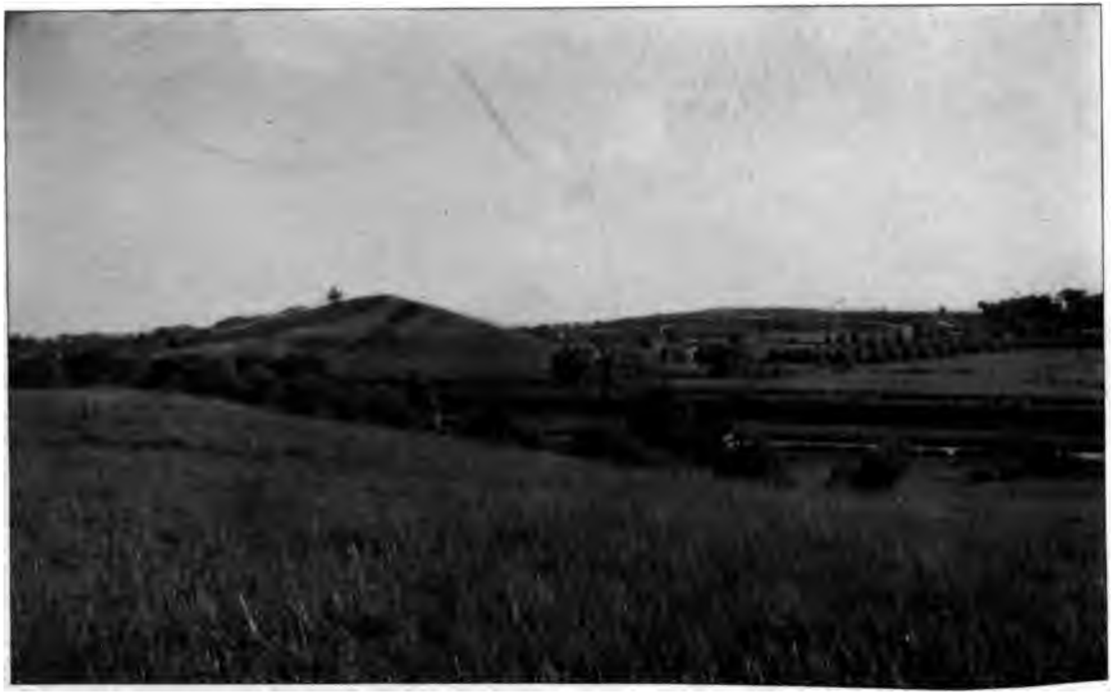
The isolation of these groups can not be entirely due to channeling by the later drainage because the drumlins which cap the island-like rock masses are not themselves eroded, but lie wholly above the plane of the river work. It appears as if the ice rubbing did not touch the lower levels but was confined to higher planes. The forms do not seem explicable on the postulate of a single ice invasion with one episode of correlating ice border drainage. The relation of the drumlins to the erosion, and the character and direction of the stream courses [pl. 9, 10] suggest a complicated history. We have here only one of several groups of phenomena which argue for more than one ice epoch with their correlated stream work.

Montezuma island groups. Plate 12 shows the largest of several groups of drumlins which rise out of the marshes that occupy the low ground north of Cayuga lake. These are not conical or cumulative masses like those described above, but isolated groups, of irregular forms and sizes, even down to single drumlins. In the Montezuma district these groups or individuals rise out of the broad marshes as if half drowned. A few small knolls are mapped about the borders of the marshes, like the summits of nearly buried drumlins, but it does not seem likely that the absence of drumlins over wide tracts could be due to entire burial of drumlins under lake and vegetal accumulations. More likely the marshes are only the low areas similar to others at higher levels that are destitute of drumlins. This leads to the next topic.

Nondrumlin areas: open spaces. The broad swamp tracts, like the Montezuma marshes, belong in this category as well as more elevated and drier areas. An example of the latter lies north of Clyde, where a large tract in the center of the Clyde quadrangle shows white on the topographic sheet. The east edge of this tract is shown in plate 3, figure 3. This surface was under Iroquois waters but the lack of drumlins is certainly not due to their destruction. Evidently they were not formed in this tract. The reason is obscure, since the area is irregular in shape with scattering drumlins on all meridians and close set on the west, east and south. This absence of drumlins over considerable tracts in the midst of heavy development is more difficult of explanation than the formation of the drumlins themselves

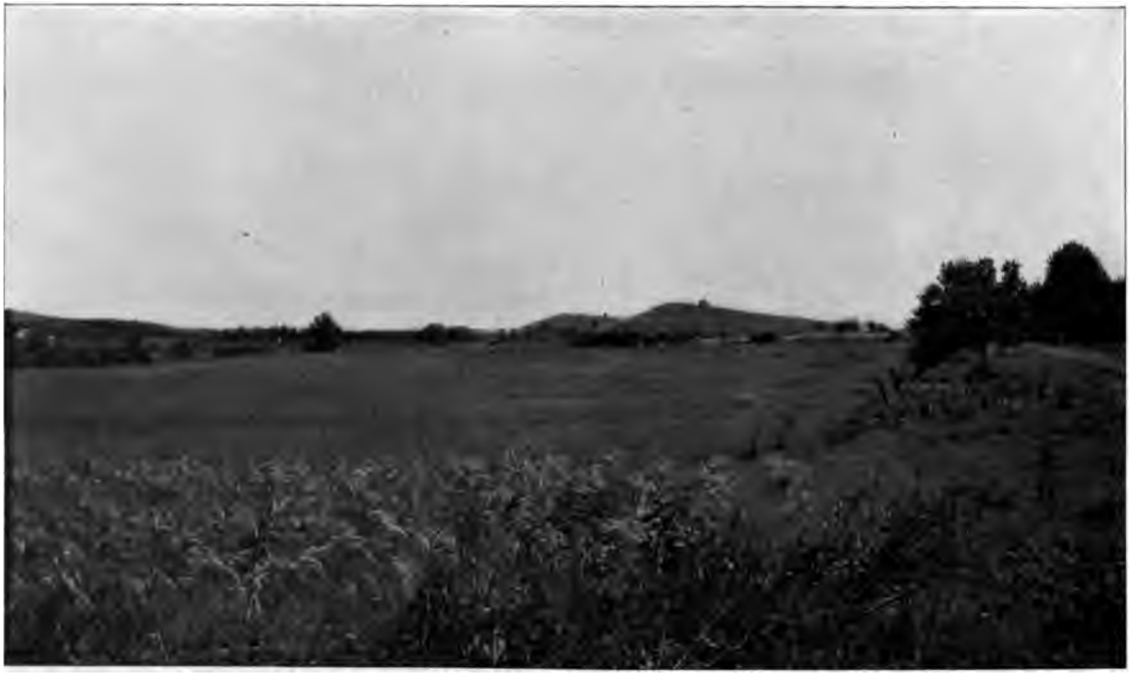
These puzzling features lie in the region of deep drift filling of ancient valleys, the northward continuation of those now holding

Plate 34

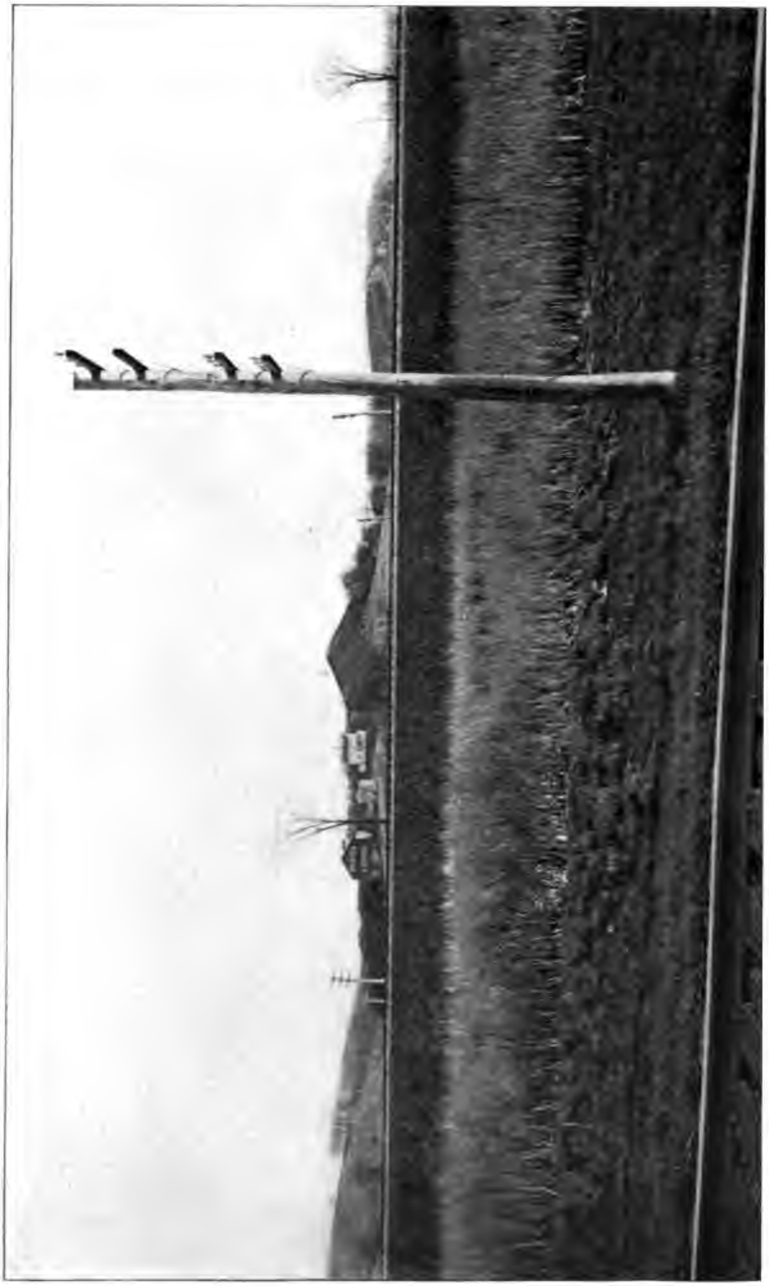


Eroded north end of drumlin, 2 miles southeast of Clyde. Looking west of south. Erie canal and railroads in middle view

Plate 35



Abrupt north ends of drumlins, 1½ miles southeast of Clyde. Looking southeast



the finger lakes, and chiefly in the north and south depression of Sodus bay and Cayuga lake. The nondrumlin spaces can not be regarded as having been occupied by stagnant ice during the drumlin-shaping episode since they are surrounded by drumlins, and are comparatively free from moraine. They can not represent areas of ice movement too vigorous for drumlin accretion or shaping as the ice along the line of flow must have had a practical equality of motion. There is no reason for supposing that there was any lack of drift, since an immense quantity is piled in drumlins immediately southward. The location and distribution of the spaces, as well as the drumlins themselves, are such as to oppose the idea that the drumlins represent an original morainal distribution of earlier drift. We have to recognize the probable equality of the drumlin and nondrumlin loci in the elements of depth and pressure of the ice, in its impact and velocity of motion and in its burden of drift

The following suggestions are offered toward the explanation of these puzzling features. In the region of deep valley filling it is possible that some depressions were below the average level and consequently below the plane of the more vigorous thrustal motion, and it is conceivable that a plane of shearing might have been established above the depressions. Shearing once established would probably be unfavorable to the initiation of drumlins, as the drumlins imply some degree of local drag in the bottom ice during the time of accretion or shaping of the forms. The lowest of the open spaces have been partly filled with lake silts and stream detritus and vegetal accumulation, and some are still partly under water, as the Montezuma marshes; but the spaces north of Clyde do not appear to have been leveled by postglacial agents. The existence of well developed drumlins within or on the borders of open spaces might be due to accretion on existing obstructions, while the shearing tendency discouraged initiation of new masses.

A second suggestion is based on the idea of a complex glacial history. An earlier ice invasion may have localized and heaped the drift in part, while the interglacial stream work carved broad channels through the area, which the latest ice work has not wholly obscured.

Channels among the drumlins. These are connected with or blend into the open spaces discussed above and are part of the same problem. They are specially developed between Fairport and

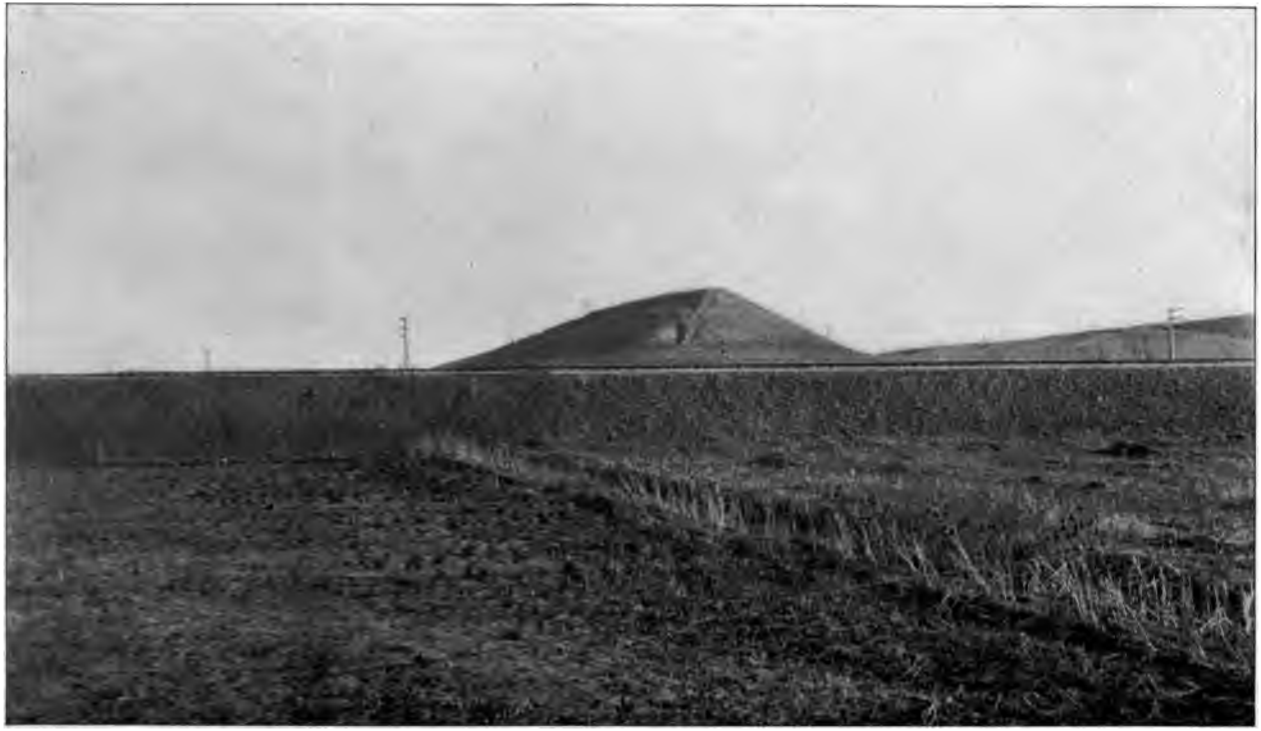
Lyons; between Montezuma and Syracuse; and along the Seneca river. Those with direct east and west course were occupied by the latest ice border drainage but apparently were not wholly produced by it. These features appear on the Macedon, Palmyra, Weedsport and Syracuse sheets, and a suggestion of them is shown in plates 9–12. The channels all lie in Salina shales and possibly they have some genetic relation to the erodible nature of the rocks.

The existence and location of these low, continuous passages are strikingly emphasized by the remarkable windings of even the larger streams, Seneca river for example. The northward turns which this wayward stream makes east of Savannah, and more strikingly from Cross lake (an open tract) around by Baldwinsville and south to near Onondaga lake, must have been found open or the stream would have taken the direct eastward passages that are almost as low today even without any postglacial erosion. A smaller illustration is found in the case of Ganargua creek east of Palmyra, where it deserts the open glacial stream course and wilfully turns north around by East Palmyra in a constricted and uninviting pass, and repeats the act with less excuse northeast of Newark.

One suggestion for these open passages, which were certainly left open by the ice removal and were not cut by postglacial erosion, is that they were made by subglacial drainage, either under free flow or under hydraulic pressure. This seems reasonable for south-leading passages like those northeast of Clyde, and even for north-leading channels of gentle grade, like the valley of Dead creek in plate 10; but it is not satisfactory for the east and west passes which were transverse to the ice movement.

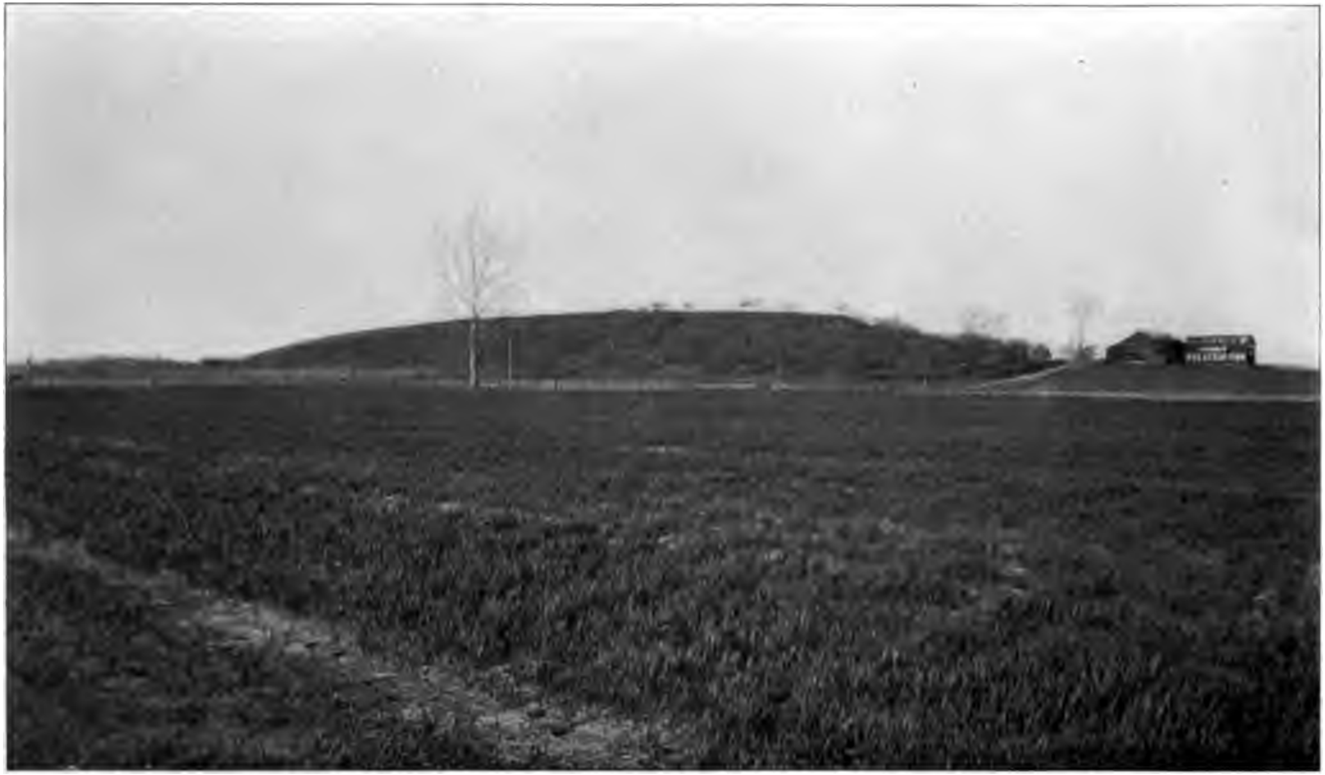
Another suggestion is that the passes were cut by glacial drainage of an earlier ice sheet, with modification by the subsequent interglacial erosion. It seems probable that the complex history of the region may involve such episodes and activities; or that perhaps the oscillations of the last (Wisconsin) ice sheet were sufficiently extensive to produce the phenomena. The difficulty under this theory is to explain why the drumlin-making work of the ice did not rub the channels full of drift. This difficulty is of the same kind, however, as the absence of drumlins over interdrumlin tracts. In the case of the deep channels around the Syracuse island masses it might be suggested that possibly during the latest stage the channels were occupied by stagnant ice over which the drumlin-forming layers

Plate 37



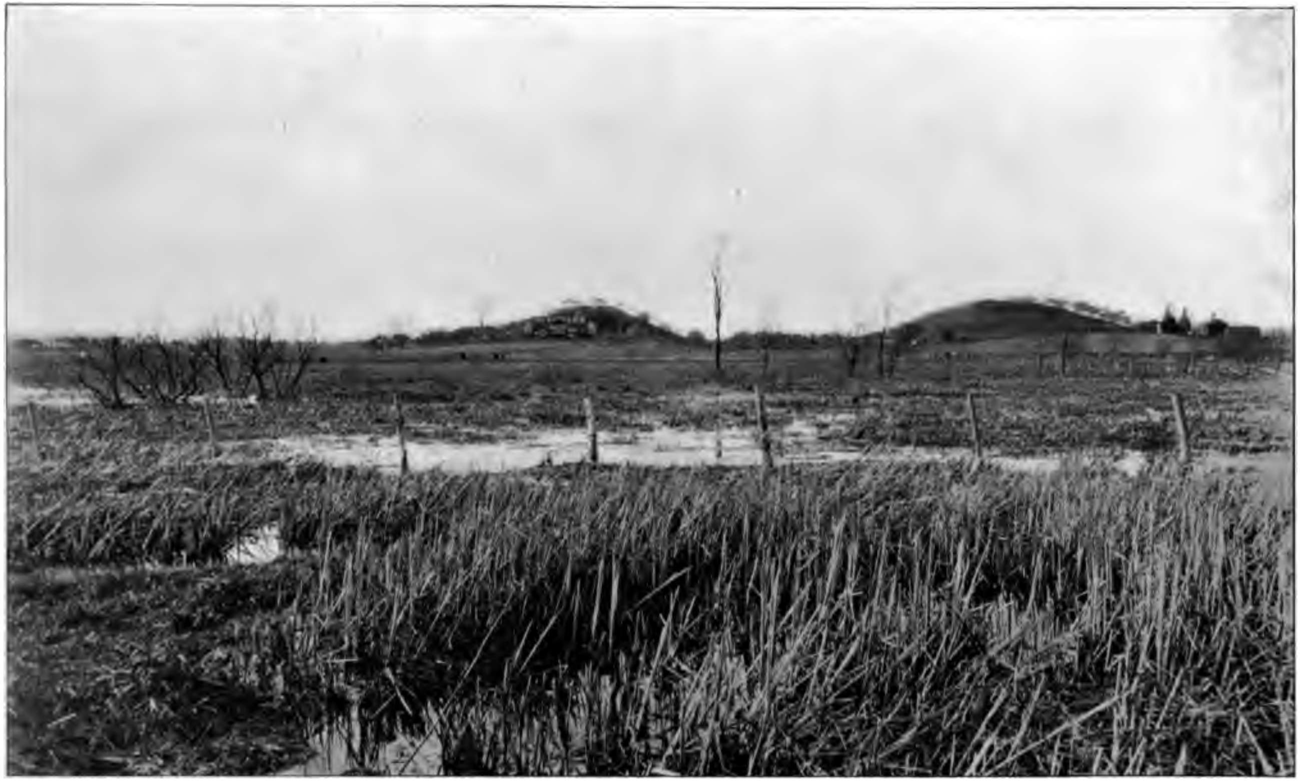
Eroded drumlin, west edge of Savannah. Looking south from New York Central Railroad. The north end cut obliquely by Iroquois waves

Plate 38



Drumlin eroded at south end by Iroquois waves. 2 miles west of Savannah; looking northeast. Note the house in the

Plate 39



South ends of drumlins 2 miles west of Savannah. End view of drumlin shown in plate 38. Looking north from tracks

moved or slid by shearing; but this could hardly apply to the Clyde and Montezuma districts, where the drumlin forms lie at the lowest levels.

A modification of the subglacial drainage theory offers some help. It seems probable that the last stage of the glacier in this region left an extensive border tract of stagnant ice, and that unequal melting due to a variety of causes produced detached blocks or tracts of ice around or among which the copious glacial waters excavated many channels. The subglacial drainage combined with the later inter-ice block drainage may largely account for the peculiar features. In this connection it must be understood that the attitude and elevation of the land surface of the region has changed to some extent since the features were made; and that the lakes and sluggish waters, aided by organic growths, have partially filled the low grounds.

Summary

Age of the drumlins. The form and relations of the drumlins in the Pulaski district, due to the change of direction in the ice flow proves that they were shaped during the latest phase of the ice work in that locality, and not during any earlier stage. The same conclusion is reached by the theoretical considerations and enforced by the facts of observation for the entire drumlin area.

The peculiar distribution of the drumlins and their orientation prove that they were shaped by the spreading flow of the semistagnant ice mass reposing in the Ontario basin. The correlation of moraines and of ice border drainage channels with the attenuated edge of the main belt of drumlins indicates that the drumlins were formed beneath the border of the ice sheet. This correlation of the drumlin shaping with the latest work of the ice in the drumlin region has been noted in other drumlin areas, as Wisconsin, Massachusetts, Ireland and Germany. The fact seems to be sufficiently established that the alinement and shaping of the drumlins was given under the waning border of the ice sheet, at least in the case of the continental glaciers.

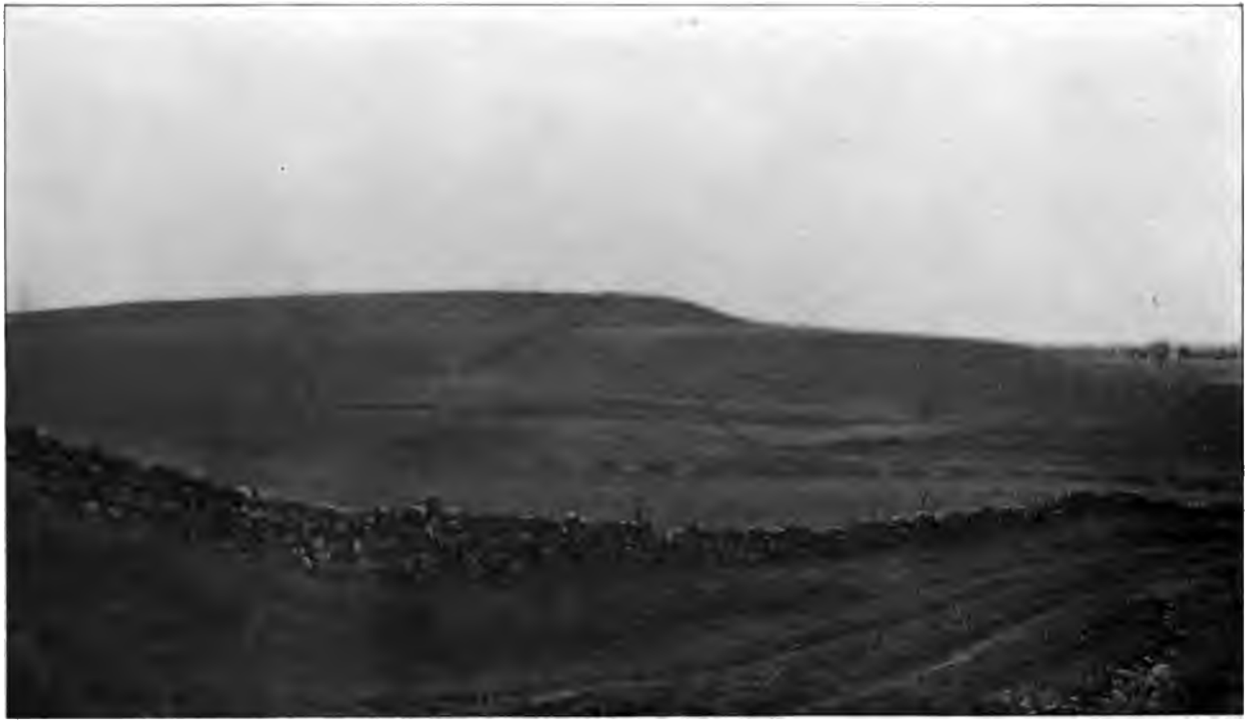
Thrust motion of the ground contact ice. Drumlins are shaped by the sliding movement of the lowest ice, that in contact with the land surface. This fact implies that the whole thickness of the ice sheet participated in the motion. Such motion was not due to gravitational stress on the ice mass over the drumlin area, because the general slope of the drumlin area is up hill, but was produced by an effective thrust on the marginal ice by the pressure of the rearward mass. As the ice sheet thinned by ablation there came a time when the drift-loaded ice in contact with the ground was subjected to less vertical pressure and to relatively greater horizontal pressure by the deep ice in the rear, and was *pushed forward, bodily.* In this fact is believed to lie the key to drumlin formation.

It does not follow that drumlins must always have been formed where the bottom ice had a sliding motion, as several other conditions are probably requisite, but it seems quite certain that long-continued and vigorous horizontal thrust is the prime necessity. Such thrustal movement would be effective only where a border of the ice sheet was backed by a thick or vigorously pushing rearward mass. The combination of conditions requisite for effective thrust movement over a belt of country and for the considerable time necessary to build up the drumlins may be rare. It does not seem so strange that drumlins are uncommon features of the drift when we add to the requisite dynamic factors mentioned above the several others which are doubtless directly concerned with the drumlin formation.

As a working hypothesis it may be assumed that wherever the ground contact ice had a vigorous movement of some duration it should be indicated by the molding of the ground surface, specially where that surface is comparatively smooth and composed of drift or soft rocks. The form and degree of the ice molding would vary according to the strength and adjustment of the several factors. An application of this idea can be made to the region under present study.

Well marked drumlins are not found on the high ground east of Seneca lake, and are wanting on the low ground east of Syracuse. The explanation seems to lie in the relationship of the larger topography to the movement of the ice sheet. When the glacier was deep over the Finger lakes region the bottom of the ice in the drumlin area was probably quiescent and served as the bridge over which the upper ice moved by gravity; the repose of the lower ice probably being due to the opposing land slope and to the large volume of drift which the ice had incorporated. Over the nearly level area north of the Finger lakes the waning of the ice sheet finally subjected the ground-contact ice to a vigorous and long-continued horizontal thrust with consequent sliding motion. But in the adjacent

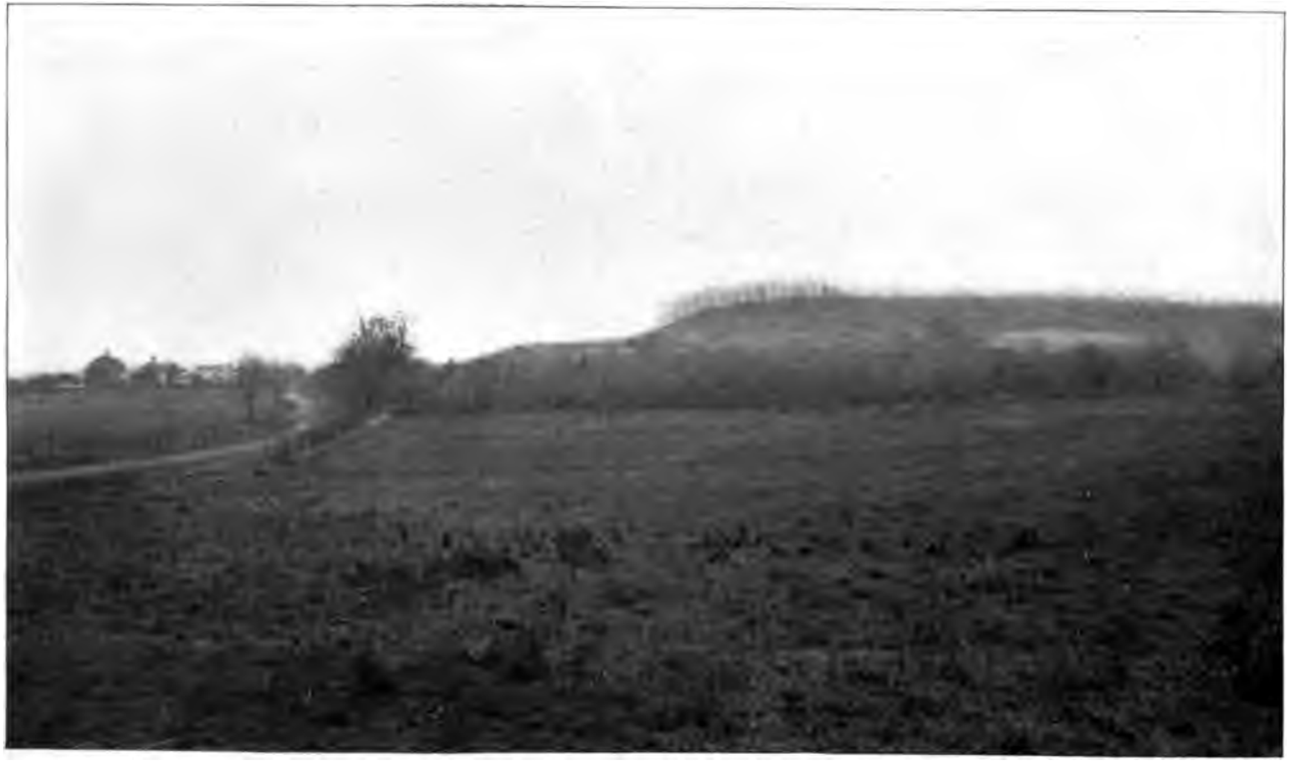
Plate 40



Superposed drumlin. Cushman hill, 2½ miles northwest of Scottsville. Looking south of west

Plate 41

Plate 42



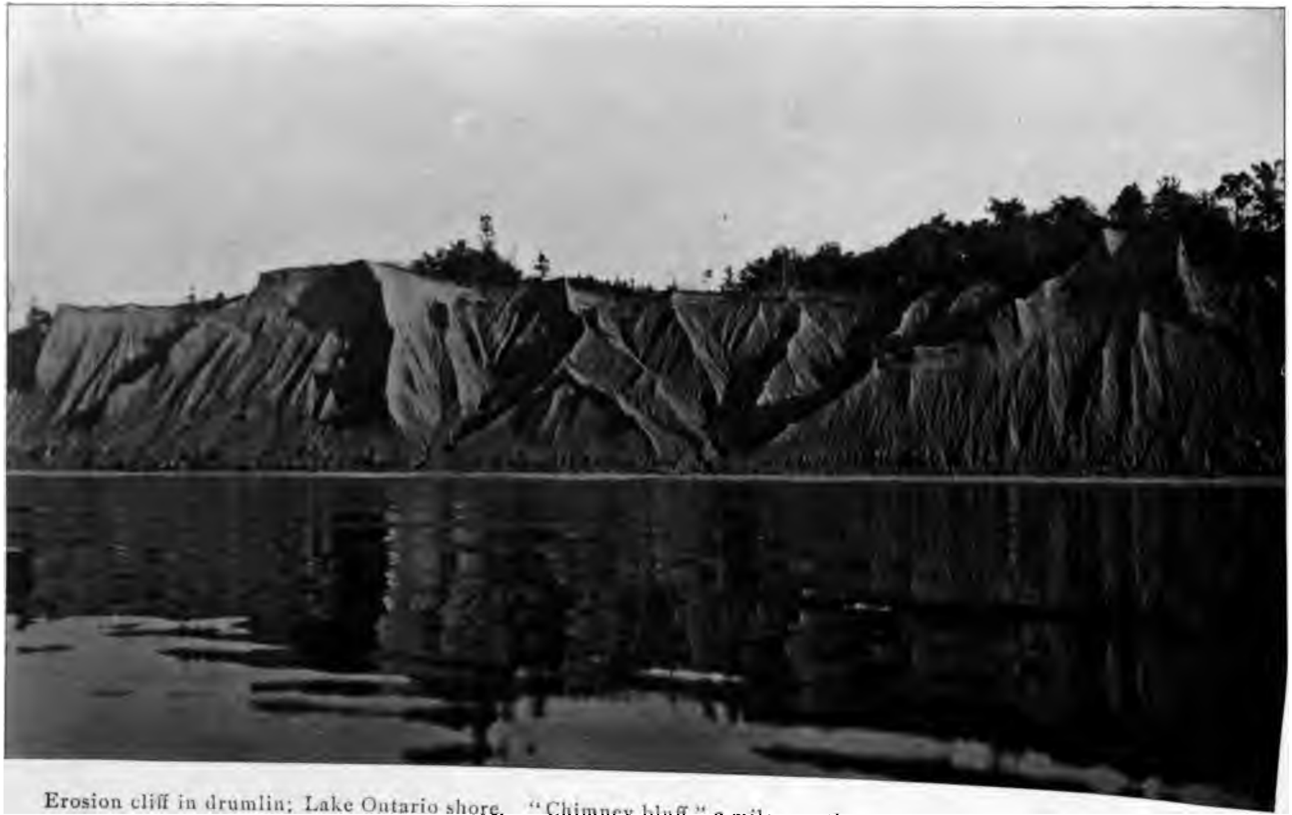
Superposed drumlin. Martin hill 1 mile east of West Rush. Looking south of east

district of low ground northeast and east of Syracuse (over Oneida lake, Canastota, Oneida and eastward) we have an illustration of nonmotion of the ground-contact ice. The almost bare hills of soft Vernon shales in the region of Canastota have not been subjected to the rubbing action of the ice from any direction. In form these clay hills closely resemble moraine drift, and with their slight veneer of glacial rubbish would at first be mistaken for moraine by even the experienced geologist. This surface would have been sensitive to any ice movement, the absence of which is explained as follows: While the ice sheet was thick the flow was from the northward and the ground-contact ice in this district, lying in the broad depression between the Adirondack massive on the north and the high plateau on the south, was quiescent. With the waning of the ice sheet it disappeared from the high ground to the north so that the stagnant mass resting on the Canastota-Oneida district was not subjected to any push from the northward. During the closing or drumlin-making phase of the ice work in the Ontario basin the radially spreading ice of the Ontarian mass did not reach this district. In brief, the ground-contact ice over the Canastota-Oneida district, although occupying a low tract on the edge of the drumlin area, did not at any time receive horizontal impulse but was deserted and allowed to quietly melt away, or perhaps to be lifted and rafted off in the glacial lake waters which fronted the glacier. The extreme reach of the drumlin-forming activity in the Syracuse district was in the form of a tongue or wedge of moving ice which was thrust southeastward along the Onondaga lake depression and over the site of Syracuse, ending a few miles southeast of the city; and affecting only the higher ground, or the summits of the island masses.

Origin. It is certain that the New York drumlins were constructed or built up by a plastering-on process. The ice did not drop its drift burden in the depressions or low places but plastered it on the obstructions. The plastic and adhesive character of the shale-derived drift of central New York is probably one factor accounting for the great number, hight and shape of the drumlins of that district.

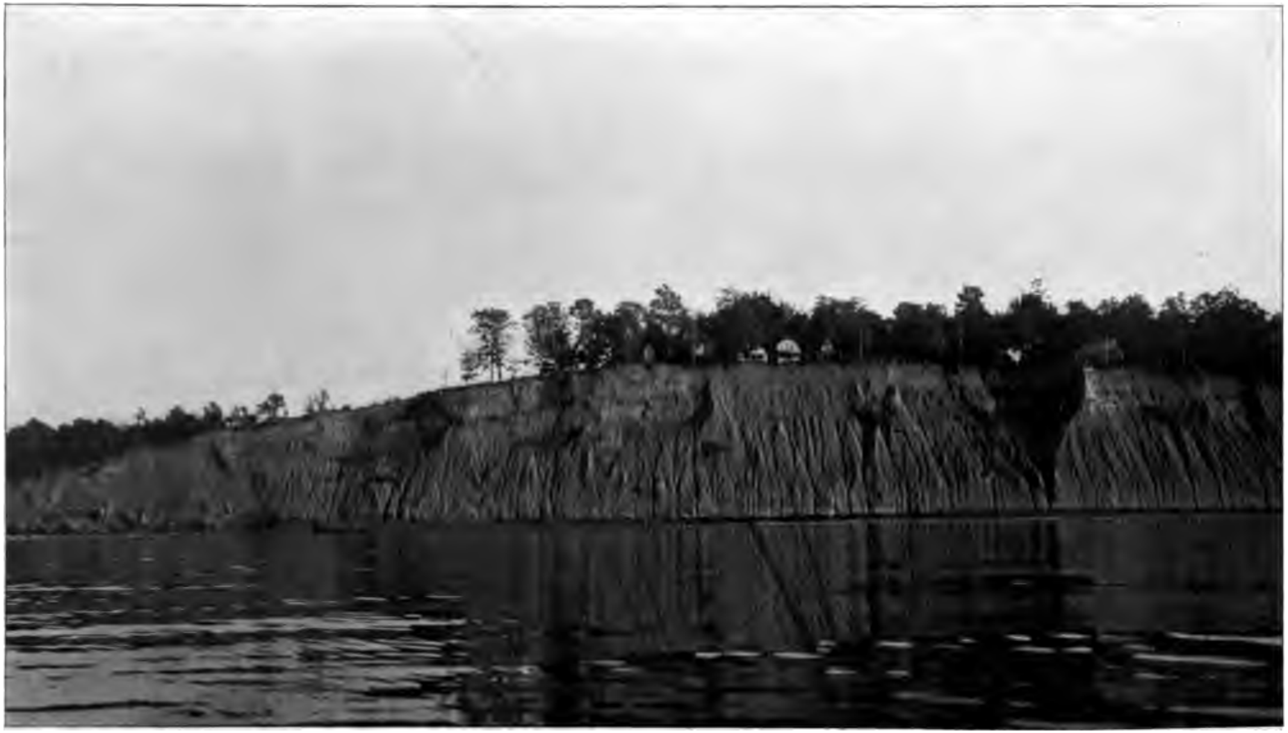
The rocdrumlins, or shale hills with the peculiar drumlin form, being shaped by a moderate amount of erosion of the soft rock might suggest, at first thought, that erosion was the main factor in drumlin formation. Possibly it may be in some regions; but vig-

Plate 43



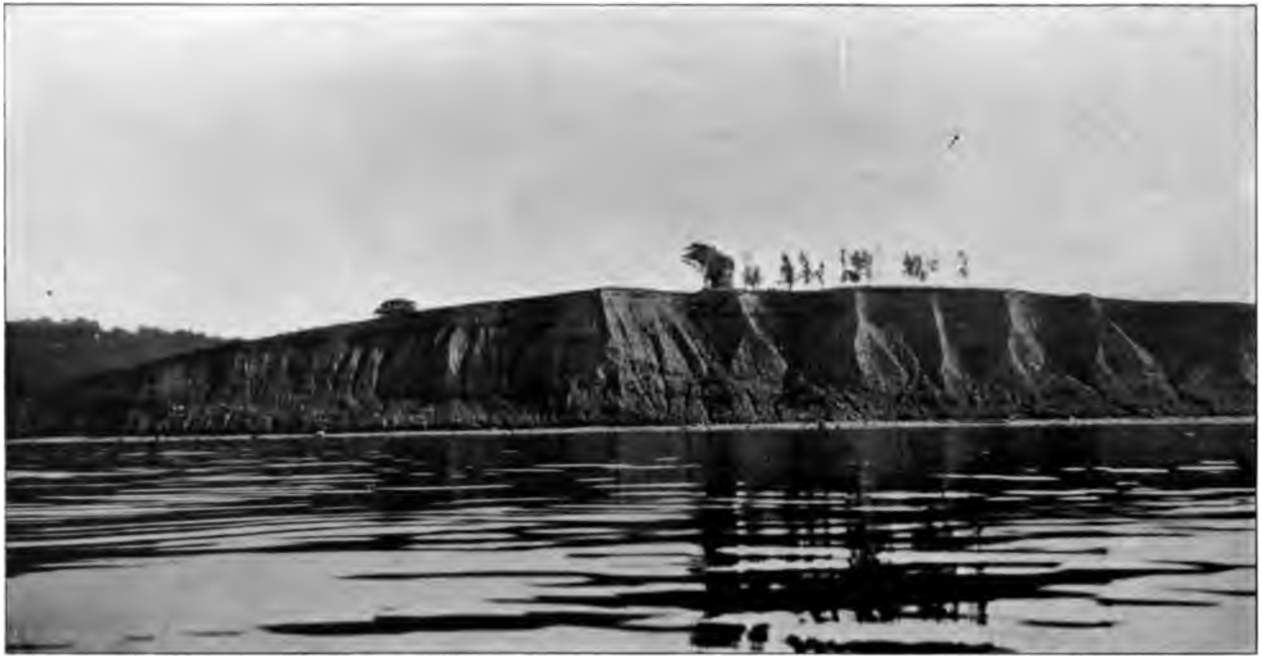
Erosion cliff in drumlin; Lake Ontario shore. "Chimney bluff," 2 miles northeast of Sodus ba

Plate 44



Foliated drumlin structure. "Lake Bluff," Sodus bay, shore of Lake Ontario. Looking southeast

Plate 45



Foliated drumlin structure. "Blind Bay bluff," shore of Lake Ontario, 5 miles northeast of Sodus bay. Looking south due to some obstruction beneath the ice or to a local amassing of drift by the ice itself.

Drumlin forms. The breadth of the Oakfield-Scottsville-Palmyra-Syracuse drumlin belt or series, which is supposedly a unit in time of formation, is about 20 miles wide in the central part. The eastern Ontario series has about the same width on the Fulton sheet.

If the northern and broader drumlins in each belt were mostly built contemporaneously with the southern attenuated forms, as seems most probable, then we may assign a few of the conditions that were responsible for the different forms.

The northern, broader and more widely separated drumlins, such as those at Sodus [pl. 4], were certainly under greater vertical pressure on account of the greater depth of the ice. This might have given greater potential plasticity, though the effective plasticity and the differential movement might have been less than in the central part of the belt. On the other hand the attenuated drumlins [pl. 13] under the thinner ice near the border of the sheet would be subject to less vertical pressure. Here the ice had less frontal resistance and therefore freer movement; it was less burdened with drift, having already built the drumlins in the rear; and probably it had less effective plasticity and less differential movement. In other words, the attenuated, border forms of the drumlin belt were formed beneath ice moving with relatively greater freedom, greater relative rigidity, and with more uniformity and continuity.

The culmination of the drumlin-making process seems to have been in the middle of the belt, where the several dynamic factors were well balanced and were working together at the maximum of efficiency. There the drift was abundant and plastic; the rigidity and the plasticity of the ice were active but well balanced; and the differential flow was at its maximum, that is to say, the ice was not moving in long, rigid bolts or wide masses but in short and wavering prisms.

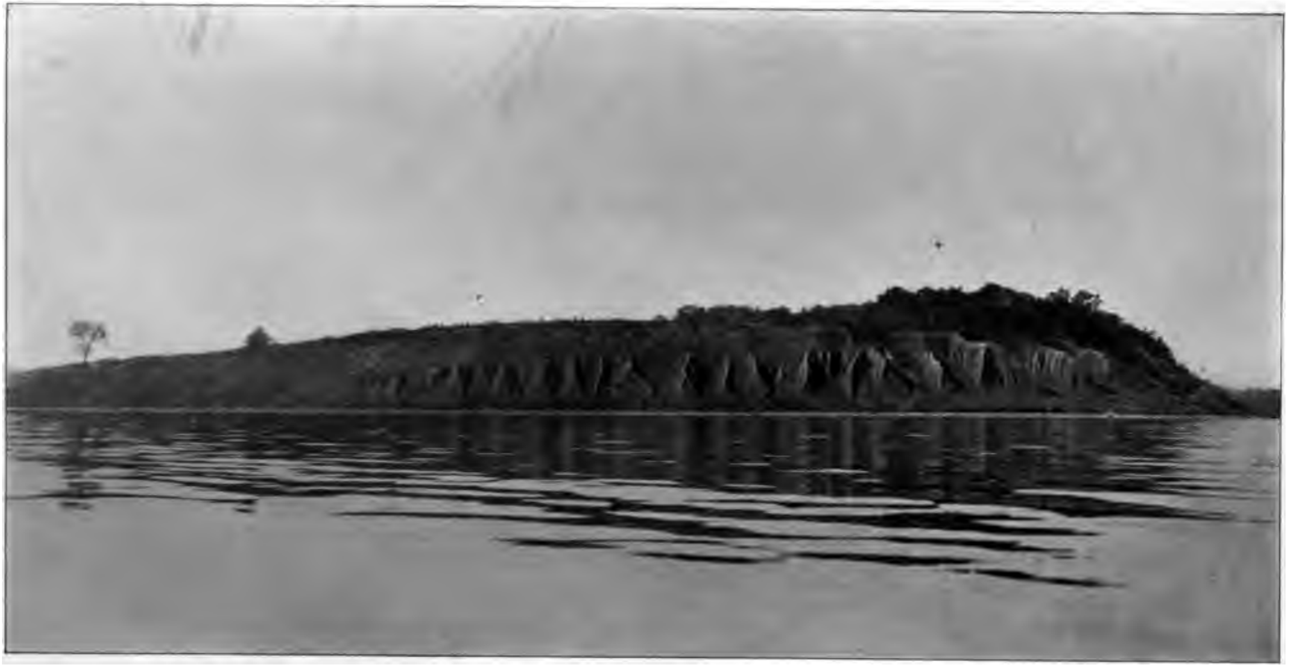
The very long and flat ridges characteristic of the Niagara-Genesee prairie [pl. 18, 19] seem to be the product of steady and long-continued movement of thicker and more rigid ice than that which built the shorter, steeper and crowded drumlins in the middle of the State. The ice probably had less burden of drift, less differential flow and less effective plasticity. The effect was similar to the production of the small, linear forms on the attenuated drumlin border in the Waterloo-Seneca Falls district, but the work was on a much larger scale. The direction of the drift molding in the western district, it should be noted, is that of the prevailing direction of the continental glacier over the region.

Depth of the drumlin-making ice. We have no conclusive facts on this topic but some suggestive data. The relationship of the Waterloo-Seneca Falls moraine, and of the ice-border drainage channels on the west, to the south edge of the main drumlin series seems to locate definitely the edge of the ice sheet during that episode. North of the Finger lakes region the receding ice front was continuously bathed by glacial lake waters, and the moraines were laid down under water. The moraine above named seems to correlate with certain deltas and outlet channels to the east. If the correlation is correct the water in which the moraine was deposited had a surface altitude, present elevation, of about 900 feet. The depth of water at the ice front was therefore about 400 feet, since the moraine tract lies at about 500 feet.

As the moraine is weak, largely because the drift load had been incorporated into the drumlins in the rear, we may assume that the ice was not heavily anchored in the lake water by its load of rock rubbish. In order to retain its place under the buoyancy of the waters it must have been at least 450 feet thick, or 50 feet above the water. Taking this as the minimum depth of ice at the glacier margin and assuming a surface slope of 30 feet to the mile, the elevation of the surface of the glacier over Clyde, 12 miles north of the moraine, would be (950+30x12) about 1310 feet. Since the general base of the Clyde drumlins is about 400 feet elevation the depth of ice in the center of the drumlin belt was about 900 feet. The drumlins are less than 200 feet high, which gives a depth over their tops of more than 700 feet of ice. This is merely suggestive.

Complex history. It is very likely that there are undiscovered and unsuspected elements in the Pleistocene history of central-western New York, and that it is much more complicated than it now appears. Probably there has been more than one epoch of ice invasion and retreat along with heavy erosion by glacial and nonglacial waters. As we see the drumlins today they represent in their forms, in each series, the latest ice work; but it is quite possible that some of them were related to an earlier ice sheet.

Plate 46



Foliated drumlin structure. "Nigger hill," 4 miles west of Sodus point, shore of Lake Ontario. Looking southwest

Plate 47

Drumlins of Ireland

The remarkable series of drumlins described by Kinahan and Close[1] have a special interest in this study, as they are the type forms, produced by local glaciation in a far distant land, and are strikingly similar in essential features to our New York forms.

The distribution of the principal group of the Irish drumlins is shown on plate 47 which is a copy, in reduced size, of a portion (upper right corner) of the original map by the Irish authors. The direction of flow of the ice current that produced this group of drumlins was toward the north, and spreading specially to the west, toward Clew bay; but in other districts the few drumlins have other directions, corresponding to the radial flow of the ice away from the local center of accumulation. The arrangement of the drumlins in curving lines of the ice flowage is very striking, and not easily explained except by the constructional theory of their genesis.

The drumlins are described as occurring only on low ground, and even forming islands and shoals in the sea (Clew bay). Their absence from some parts of the low plain is noted as a feature not understood.

The up stream ends of the drumlins (with reference to the ice currents) are noted as the blunt ends, although this is not stated as a constant feature, since the hills have suffered some erosion by marine submergence.

The "parallel shaping" of the general ground surface in the drumlin district was observed.

The extreme hight of the drumlins is given as 180 feet, in striking accordance with the New York forms. Another important observation is the "observable uniformity in size in the same neighborhood." Concerning length it is noted that several of the drumlins are 2 miles long; and that the mean length is not less than ½ mile.

With reference to the composition the authors say that the drumlins "consist of stiff, unstratified boulder clay, containing well blunted and scratched stones and blocks." "They have been unquestionably formed by some operation different from, and antecedent to, that which produced the water-arranged gravels and eskers. Deposits of water-formed gravel, etc., clearly of later date, often occur in the lower ground between the drumlins, and even banked up against them."

---

[1] Kinahan, G. H. & Close, H. M. General Glaciation of Iar-Connaught and its Neighborhood, in the Counties of Galway and Mayo. With map. Dublin 1872.

For the favor of seeing this somewhat rare pamphlet and using its matter and map the writer is indebted to Mr F. B. Taylor.

The authors apparently regarded their drumlins as constructional forms and did not regard the matter as needing discussion, since they refer to the origin of the drumlins only incidentally, as follows:

"No agent which can not do both kinds of work, rock-scoring and drumlin-heaping, can be proposed as having caused them" [p. 9].

". . . And it has formed the drumlins by an operation evidently similar to that by which a stream of water often makes longitudinal ridges of sand in its bed."

Bibliography

The following list of writings in English relating to drumlins is not exhaustive, and it is possible that some valuable references have been overlooked, specially of foreign authors. Numerous incidental references have been purposely omitted. Outside of English the literature seems scanty, but an important paper in German is noted on page 394.

Persons unfamiliar with the phenomena of drumlins might well begin the study by reading the paper by W M. Davis that is given as his fourth title in the following list; and later the papers by Warren Upham for the years 1889, 1892 and 1893.

Barton, G. H. Bost. Soc. Nat. Hist. Proc. 1892. 26: 23–25.
——— Glacial Origin of Channels on Drumlins. **Geol. Soc. Am. Bul.** 1894. 6: 8–13.
Bonney, T. G. Ice-work, Past and Present. 1896. p. 116–19.
Chalmers, Robert. Geol. & Nat. Sur. Can. An. **Rep't. n. s.** 1888–89. p. 23 N.
Chamberlin, T. C. U. S. Geol. Sur. 3d An. Rep't. 1881–82. p. 306.
——— Geol. Wis. 1883. 1: 283.
——— Am. Ass'n Adv. Sci. Proc. 1886. 35: 204.
——— Horizon of Drumlin, Osar and Kame Formation. **Jour. Geol.** 1893. 1: 255–67, 521–24.
——— Am. Geol. 1893. 12: 176.
——— Geol. Soc. Am. Bul. 1895. 6: 216.
——— The Great Ice Age. Ed. 3. 1895. p. 743–45. **(James Geikie)**
——— **& Salisbury, R. D.** Geology. 1906. 3: 360.

Close, H. M. On the Glaciation of the Rocks near Dublin. Roy. Geol. Soc. Ireland. Jour. 1864. 1: 3.

——— Notes on the General Glaciation of Ireland. Roy. Geol. Soc. Ireland. Jour. 1866. 1: 207.

——— Roy. Geol. Soc. Ireland. Jour. 1877. 5: 49.

Dana, J. D. Am. Jour. Sci. 1883. ser. 3. 26: 357–61.

Davis, W. M. & Shaler, N. S. Illustrations of the Earth's Surface; Glaciers. 1881. Text describing plate 24.

——— Bost. Soc. Nat. Hist. Proc. 1883. 22: 34, 40–42.

——— Drumlins. Science. 1884. 4: 418–20.

——— The Distribution and Origin of Drumlins. Am. Jour. Sci. 1884. ser. 3. 28: 407–16.

——— Bost. Soc. Nat. Hist. Proc. 1893. 26: 17–23.

——— Physical Geography. 1898. p. 338.

Fairchild, H. L. Glacial Geology of Western New York. Geol. Mag. Lond. 1897. n. s. dec. 4. 4: 532.

——— Glacial Geology in America. Am. Ass'n Adv. Sci. Proc. 1898. 47: 257–90; Am. Geol. 1898. 22: 154–89; Am. Sci. Sup. 1898. no. 1183–85.

——— Elements of Geology. (LeConte) 1903. p. 71, 571.

——— New York drumlins (abstract). Geol. Soc. Am. Bul. 1905. 16: 576.

——— Drumlin Structure and Origin. Geol. Soc. Am. Bul. 1907. 17: 702-7.

Geikie, James. Geol. Soc. Glasgow. Trans. 1867. 3: 61.

——— The Great Ice Age. 1895. Ed. 3. p. 17, 81, 411, 432, 743–45. (T. C. Chamberlin)

——— Earth Sculpture. 1898. p. 234–35, 245, 378.

Hall, James. Geol. N. Y.: Rep't on Fourth District. 1843. p. 341, 414–15.

Hall, *Sir* James. Roy. Soc. Edinburgh. Trans. 1815. 7: 169.

Harte, W. Roy. Geol. Soc. Ireland. Jour. 1867. 2: 30.

Hitchcock, C. H. Lenticular Hills of Glacial Drift. Bost. Soc. Nat. Hist. Proc. 1878. 19: 63–67.

——— Lenticular Hills. Am. Jour. Sci. 1884. III. 27: 72.

Johnson, Laurence. Parallel Drift Hills of Western New York. N. Y. Acad. Sci. An. 1883. 2: 249–66, pl. 18. N. Y. Acad. Sci. Trans. 1882. 1: 78-80.

Kinahan, G. H. & Close, H. M. General Glaciation of Iar-Connaught and its Neighborhood, in the Counties of Galway and Mayo. Map. Dublin 1872.

Leverett, Frank. Illinois Glacial Lobe. U. S. Geol. Sur. Monogr. 38. 1889. p. 73, 135.

——— Glacial Formations and Drainage Features of the Erie and Ohio Basins. U. S. Geol. Sur. Monogr. 41. 1902. p. 691–93, pl. III.

——— Mich. Acad. Sci. 6th An. Rep't. 1904. p. 102.

——— Drumlins in the Grand Traverse Region of Michigan. Geol. Soc. Am. Bul. 1905. 16: 577.

Lewis, H. C. Second Geol. Sur. Pa. Rep't Z. 1884. p. 28.

Lincoln, D. F. Glaciation in the Finger Lakes Region of New York. Am. Jour. Sci. 1892. III. 44: 290–301.

——— N. Y. State Mus. Rep't 48. 1894. 2: 69–71.

Marbut, C. F. & Woodworth, J. B. Clays about Boston. U. S. Geol. Sur. 17th An. Rep't. 1896. p. 995–98.

Matthew, G. F. Geol. & Nat. Hist. Sur. Can. Rep't of Prog. 1877–78. p. 12–14 EE.

Russell, I. C. Jour. Geol. 1895. 3: 831.

——— Glaciers of North America. 1897. p. 24–28.

——— Geol. Sur. Mich. 1904. p. 69–81.

——— Drumlin of Michigan. Geol. Soc. Am. Bul. 1907. 17: 707.

——— Drumlin Areas in Northern Michigan. Geol. Soc. Am. Bul. 1905. 16: 577–78.

Salisbury, R. D. Geol. Sur. N. J. An. Rep't 1891. p. 71–74.

——— Am. Geol. 1893. 12: 172.

——— Geol. Soc. Am. Bul. 1893. 4: 9.

——— Glacial Geology. Geol. Sur. N. J. 1902. 5: 103.

——— **& Chamberlin, T. C.** Geology. 1906. 3: 360.

Shaler, N. S. Bost. Soc. Nat. Hist. Proc. 1868. 11: 27.

——— On the Parallel Ridges of Glacial Drift in Eastern Massachusetts. Bost. Soc. Nat. Hist. Proc. 1871. 13: 196–204.

——— **& Davis, W. M.** Illustrations of the Earth's Surface: Glaciers. 1881. 4: 60–63.

——— U. S. Geol. Sur. 7th An. Rep't. 1886. p. 321–22.

——— U. S. Geol. Sur. 9th An. Rep't. 1888. p. 550–51.

Stone, G. H. Bost. Soc. Nat. Hist. Proc. 1881. 20: 434; Port. Soc. Nat. Hist. Proc. 1881. Mar. 11, Nov. 21.

Tarr, R. S. Origin of Drumlins. Am. Geol. 1894. 13: 393–407.

——— Physical Geography of New York State. 1902. p. 144–51.

——— New Physical Geography. 1904. p. 152–53.

Taylor, Frank B. Distribution of Drumlins and its Bearing on their Origin. Geol. Soc. Am. Bul. 1907. 17: 726.

Tyrrell, J. B. Geol. Sur. Can., An. Rep't. 1888–89. n. s. 4: 22 A.

——— Geol. Soc. Am. Bul. 1890. 1: 402.

——— Geol. Sur. Can. 1892. 6: 15 A.

——— Am. Geol. 1893. 11: 132, 175.

Upham, Warren. Geology of New Hampshire. 1878. 3: 285–309.

——— Glacial Deposits in New England. Am. Ass'n Adv. Sci. Proc. 1879. 28: 309–10.

——— Glacial Drift in Boston and Vicinity. Bost. Soc. Nat. Hist. Proc. 1879. 20: 220–34.

——— Marine Shells and Fragments of Shells in the Till near Boston. Bost. Soc. Nat. Hist. Proc. 1888. 24: 127–41; Am. Jour. Sci. 1889. ser. 3. 37: 359–72.

——— Structure of Drumlins. Bost. Soc. Nat. Hist. Proc. 1889. 24: 228–42.

——— Inequality of Distribution of the Englacial Drift. Geol. Soc. Am. Bul. 1891. 3: 134–48.

——— Criteria of Englacial and Subglacial Drift. Am. Geol. 1891. 8: 376–85.

——— Conditions of Accumulations of Drumlins. Am. Geol. 1892. 10: 339–62.

——— Geol. Soc. Am. Bul. 1892. 3: 140.

——— Origin of Drumlins. Bost. Soc. Nat. Hist. Proc. 1893. 26: 2–17.

——— Madison Type of Drumlins. Am. Geol. 1894. 14: 69–83.

——— Drumlin Accumulation. Am. Geol. 1895. 15: 194–95.

——— Drumlins and Marginal Moraines of Ice Sheets. Geol. Soc. Am. Bul. 1896. 7: 17–30.

——— Drumlins Contained or Lying on Modified Drifts. Am. Geol. 1897. 20: 383–87.

——— Valley Moraines and Drumlins in the English Lake District. Am. Geol. 1898. 21: 165–70.

——— Drumlins in Glasgow. Am. Geol. 1898. 21: 235–43.

Wright, G. F. Bost. Soc. Nat. Hist. Proc. 1876. 19: 58.

——— Bost. Soc. Nat. Hist. Proc. 1881. 20: 217.

——— Ice Age in North America. Ed. 4. 1891. p. 251–67.

——— Man and the Glacial Period. 1893. p. 75.

INDEX

Albion sheet, 396.
Areal distribution, 394-99.
Athabasca, drumlins, 394.
Attica-Geneva series, 398.

Barton, George H., cited, 394, 406, 436.
Bibliography, 436-39.
Blind Bay bluff, 418.
Bonney, T. G., cited, 436.
Brockport sheet, 396.

Camillus shales, 414.
Canada, drumlins, 394.
Canastota, Salina shales, 396.
Cazenovia lake, drumlins, 399.
Chalmers, Robert, cited, 436.
Chamberlin, T. C., cited, 392, 394, 436.
Channels among drumlins, 427-29.
Chautauqua lake, drumlins, 399.
Cline's bluff, 418.
Clinton shale, thickness, 404.
Close, H. M., cited, 392, 435, 437.
Clyde sheet, 396, 426.
Cobleskill limestone, thickness, 404.
Concentric bedding, 416-19.
Connecticut, drumlins, 394.

Dana, J. D., cited, 437.
Dana, Lake, 396.
Davis, W. M., cited, 392, 436, 437, 438.
Dolphin back shape drumlins, 407.
Dome-shaped drumlins, 407.
Double-deck drumlins, 409.
Drift, in drumlin mass, 412; held in the ice, factors relating to, 421.
Drumlinized drift, 393.
Drumlins, age, 429; altitude and hight, 411; areal distribution, 394-99; area, amount of land surface included in, 399; bibliography, 436-39; change to drift, 399; change to moraines, 399; channels among, 427-29; composition and structure, 412-19; concentric bedding, 416-19; definition, 392-93; depth of the drumlin-making ice, 434; district of no elevated, 403; double-deck, 409; dynamic factors pertaining to the ice body, 420-21; dynamics, 432-33; factors of external control, 422; factors relating to the drift held in the ice, 421; formation, theoretical mechanics, 419-20; form and dimensions, 405-12; forms, 392, 433-34; forms and observed relations, 422-24; highland, 403; hight, 398, 399, 410; history of earlier study, 392; internal structure, 413, 416; of Ireland, 392, 394, 435-36; length, 412; most massive development, 403; name first applied, 392; former names, 392; name can not be applied to ice-shaped rock masses, 393; New York drumlin area, 395; number in New York, 395; orientation, 399-402; origin, 431-32; constructional origin, 420; product of continental glaciers, 391; production or nonproduction, depends on movement of bottom ice, 403; relation to larger topography, 402-4; relation to moraines, 424-25; relation to underlying rock strata, 404-5; secondary or contrawise forms, 402; may be partly shale, 414; size and dimensions, 410; special features, 425-29; thrust motion of the ground contact ice, 429-31; topographic expression, 393; abrupt ending of topography, 399; wave cutting, 409.
Drumloid, term, 393.
Dynamics, 432-33.

England, drumlins, 394.

Fairchild, H. L., cited, 437.
Fairhaven, 397.

Fayetteville, Salina shales, 396.
Finger lakes series, western, 398.
Fulton, 397.

Ganargua creek, 428.
Geikie, James, cited, 392, 394, 437.
Genesee valley, 398.
Germany, drumlins, 394.

Hall, James, cited, 437.
Hall, Sir James, cited, 392, 437.
Hamilton shale, thickness, 404.
Harte, W., cited, 437.
Hartnagel, C. A., cited, 404.
Hitchcock, C. H., cited, 392, 437.

Ice body, dynamic factors pertaining to, 420–21.
Ireland, drumlins, 392, 394, 435–36.
Iroquois, Lake, 396, 397.

Johnson, Laurence, cited, 392, 437.

Keilhack, K., cited, 394.
Kinahan, G. H., cited, 392, 435, 437.

Lake bluff, 418.
Leverett, Frank, cited, 437.
Lewis, H. C., cited, 437.
Lincoln, D. F., cited, 408, 438.
Lockport limestone, thickness, 404.
Lorraine shale, thickness, 404.

Macedon sheet, 428.
Mammillary form of drumlins, 407.
Manitoba, drumlins, 394.
Manlius limestone, thickness, 404.
Marbut, C. F., cited, 438.
Marcellus shale, thickness, 404.
Massachusetts, drumlins, 394.
Matthew, G. F., cited, 392, 394, 438.
Medina shale, thickness, 404.
Medina sheet, 396.
Mexico, 397.
Michigan area, 394.
Montezuma island groups, 426.
Moraines, change to drumlins, 399; relation to drumlins, 424–25

New England, area, 394.
New York rocks along the Cayuga meridian, 404–5.
Niagara-Genesee prairie, 396, 398.
Nondrumlin areas, 426–27.
Nova Scotia, drumlins, 394.

Oakfield-Syracuse series, 398, 399, 400.
Oneida, Salina shales, 396.
Onondaga limestone, thickness, 404.
Ontario drumlin area, 395.
Ontario series, eastern, 398, 400.
Orientation, 399–402.
Oriskany sandstone, thickness, 404.
Oswego sandstone, thickness, 404.
Oswego sheet, 418.
Oval form drumlins, 407.

Palmyra sheet, 395, 396, 428.
Pulaski drumlins, 397, 400–1.
Pulaski sheet, 395.
Pultneyville sheet, 418.

Ridge form drumlins, 407.
Ridge road, 397.
Rocdrumlins, 393, 395, 413–16, 431.
Rocdrumloid, 393.
Rochester shale, thickness, 404.
Rock strata, underlying, relation of drumlins to, 404–5.
Rondout waterlime, thickness, 404.
Russell, I. C., cited, 438.

Sacketts Harbor sheet, 395.
Salina shale, 413, 416; thickness, 404.
Salisbury, R. D., cited, 438.
Sand in drumlin mass, 413.
Scandinavia, drumlins, 394.
Scotland, drumlins, 394.
Seneca river, 428.
Shale hills, *see* Rocdrumlins.
Shale in drumlin mass, 414.
Shaler, N. S., cited, 392, 437, 438.
Sodus, 397.
Sodus bay sheet, 418.
Stone, G. H., cited, 438.
Sweden, drumlins, 394.
Switzerland, drumlins, 394.
Syracuse drumlin area, 396, 397, 403.

Syracuse island masses, 425–26.
Syracuse sheet, 428.

Tarr, R. S., cited, 438.
Taylor, Frank B., cited, 424, 438.
Thrust motion of the ground contact ice, 429–31.
Till, drumlins composed of, 412.
Tyrrell, J. B., cited, 394, 438.

Upham, Warren, cited, 392, 394, 416, 436, 438–39.
Utica shale, thickness, 404.

Vernon shales, 413, 414, 431.

Warren, Lake, 396.
Watertown sheet, 395.
Wave cutting of drumlins, 409.
Weedsport sheet, 396, 428.
Wisconsin, drumlins, 394.
Woodworth, J. B., cited, 438.
Wright, G. F., cited, 439.

New York State Education Department

New York State Museum

JOHN M. CLARKE, Director

PUBLICATIONS

Packages will be sent prepaid except when distance or weight renders the same impracticable. On 10 or more copies of any one publication 20% discount will be given. Editions printed are only large enough to meet special claims and probable sales. When the sale copies are exhausted, the price for the few reserve copies is advanced to that charged by second-hand booksellers, in order to limit their distribution to cases of special need. Such prices are inclosed in [ ]. All publications are in paper covers, unless binding is specified.

Museum annual reports 1847–date. *All in print to* 1892, 50*c a volume*, 75*c in cloth;* 1892*–date*, 75*c*, *cloth*.

These reports are made up of the reports of the Director, Geologist, Paleontologist, Botanist and Entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Director's annual reports 1904–date.

These reports cover the reports of the State Geologist and of the State Paleontologist. Bound also with the museum reports of which they form a part.

Report for 1904. 138p. 20*c*. 1905. 102p. 23pl. 30*c*. 1906. 186p. 41pl. 35*c*.

Geologist's annual reports 1881–date. Rep'ts 1, 3–13, 17–date, O; 2, 14–16, Q.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899–1903. The two departments were reunited in 1904, and are now reported in the Director's report.

The annual reports of the original Natural History Survey, 1837–41, are out of print.

Reports 1–4, 1881–84, were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	17	$.75	21	$.40
14	.75	18	.75	22	.40
15, 2v.	2	19	.40	23	.45
16	1	20	.50	[*See* Director's annual reports]	

Paleontologist's annual reports 1899–date.

See first note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Those for 1901–3 were issued as bulletins. In 1904 combined with the Director's report.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Reports 3–20 bound also with museum reports 40–46, 48–58 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3–4, 17 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	10	$.35	16 (En 10)	$.25
2	.30	11	.25	18 (" 17)	.20
5	.25	12	.25	19 (" 21)	.15
6	.15	13	.10	20 (" 24)	.40
7	.20	14 (En 5)	.20	21 (" 26)	.25
8	.25	15 (" 9)	.15	22 (" 28)	.25
9	.25				

Reports 2, 8–12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Botanist's annual reports 1867–date.

Bound also with museum reports 21–date of which they form a part; the first Botanist's report appeared in the 21st museum report and is numbered 21. Reports 21–24, 29, 31–41 were not published separately.

Separate reports for 1871–74, 1876, 1888–96 and 1898 (Botany 3) are out of print. Report for 1897 may be had for 40c; 1899 for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins [*see* Bo 5–9].

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), 56th (1902), 57th (1903) and 58th (1904) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

Museum bulletins 1887–date. O. *To advance subscribers,* **$2** *a year or* **$1** *a year for division* (1) *geology, economic geology, paleontology, mineralogy; 50c each for divisions* (2) *general zoology, archeology and miscellaneous,* (3) *botany,* (4) *entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*
G 1	48, v.1	Pa 1	54, v.1	En 7–9	53, v.1	Ar 2	51, v.1
2	51, v.1	2,3	“ v.3	10	54, v.2	3	52, v.1
3	52, v.1	4	“ v.4	11	“ v.3	4	54, v.1
4	54, v.4	5, 6	55, v.1	12, 13	“ v.4	5	“ v.3
5	56, v.1	7–9	56, v.2	14	55, v.1	6	55, v.1
6	57, v.1, pt 1	10	57, v.1, pt 1	15–18	56, v.3	7	56, v.4
7–10	58, v.1	11–14	58, v.3	19–22	57, v.1, pt 2	8, 9	57, v.2
Eg 5, 6	48, v.1	Z 3	53, v.1	23, 24	58, v.5	10,11	58, v.4
7	50, v.1	4	54, v.1	Bo 3	52, v.1	Ms 1, 2	56, v.4
8	53, v.1	5–7	“ v.3	4	53, v.1		
9	54, v.2	8	55, v.1	5	55, v.1	***Memoir***	
10	“ v.3	9	56, v.3	6	56, v.4	2	49, v.3
11	56, v.1	10	57, v.1, pt 1	7	57, v.2	3, 4	53, v.2
12, 13	58, v.2	11, 12	58, v.4	8	58, v.4	5, 6	57, v.3
M 2	56, v.1	En 3	48, v.1	Ar 1	50, v.1	7	“ v.4
3	57, v.1, pt 1	4–6	52, v.1				

The figures in parenthesis in the following list indicate the bulletin's number as a New York State Museum bulletin.

Geology. **G1** (14) Kemp, J. F. Geology of Moriah and Westport Townships, Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps. Sep. 1895. 10c.

G2 (19) Merrill, F. J. H. Guide to the Study of the Geological Collections of the New York State Museum. 162p. 119pl. map. Nov. 1898. [50c]

G3 (21) Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sep. 1898. 5c.

G4 (48) Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 9pl. map. Dec. 1901. 25c.

G5 (56) Merrill, F. J. H. Description of the State Geologic Map of 1901. 42p. 2 maps, tab. Oct. 1902. 10c.

G6 (77) Cushing, H. P. Geology of the Vicinity of Little Falls, Herkimer Co. 98p. il. 15pl. 2 maps. Jan. 1905. 30c.

G7 (83) Woodworth, J. B. Pleistocene Geology of the Mooers Quadrangle. 62p. 25pl. map. June 1905. 25c.

G8 (84) —— Ancient Water Levels of the Champlain and Hudson Valleys. 206p. 11pl. 18 maps. July 1905. 45c.

G9 (95) Cushing, H. P. Geology of the Northern Adirondack Region. 188p. 15pl. 3 maps. Sep. 1905. 30c.

G10 (96) Ogilvie, I. H. Geology of the Paradox Lake Quadrangle. 54p. il. 17pl. map. Dec. 1905. 30c.

G11 (106) Fairchild, H. L. Glacial Waters in the Erie Basin. 88p. 14pl. 9 maps. Feb. 1907. 35c.

G12 (107) Woodworth, J. B.; Hartnagel, C. A.; Whitlock, H. P.; Hudson, G. H.; Clarke, J. M.; White, David; Berkey, C. P. Geological Papers. 388p. 56pl. map. May 1907. 90c, *cloth.*

Contents: Woodworth, J. B. Postglacial Faults of Eastern New York.
Hartnagel, C. A. Stratigraphic Relations of the Oneida Conglomerate.
— — Upper Siluric and Lower Devonic Formations of the Skunnemunk Mountain Region.
Whitlock, H. P. Minerals from Lyon Mountain, Clinton Co.
Hudson, G. H. On Some Pelmatozoa from the Chazy Limestone of New York.
Clarke, J. M. Some New Devonic Fossils.
— — An Interesting Style of Sand-filled Vein.
— — Eurypterus Shales of the Shawangunk Mountains in Eastern New York.
White, David. A Remarkable Fossil Tree Trunk from the Middle Devonic of New York.
Berkey, C. P. Structural and Stratigraphic Features of the Basal Gneisses of the Highlands.

G13 (111) Fairchild, H. L. Drumlins of New York. 58p. 28pl. 19 maps. July 1907. 35c.

—— Later Glacial Waters in Central New York. *Prepared.*

Cushing, H. P. Geology of the Theresa Quadrangle. *In preparation.*

—— Geology of the Long Lake Quadrangle. *In press.*

Berkey, C. P. Geology of the Highlands of the Hudson. *In preparation.*

Economic geology. **Eg1** (3) Smock, J. C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*

Eg2 (7) —— First Report on the Iron Mines and Iron Ore Districts in the State of New York. 6+70p. map. June 1889. *Out of print.*

Eg3 (10) —— Building Stone in New York. 210p. map, tab. Sep. 1890. 40c.

Eg4 (11) Merrill, F. J. H. Salt and Gypsum Industries of New York. 92p. 12pl. 2 maps, 11 tab. Ap. 1893. [50*c*]

Eg5 (12) Ries, Heinrich. Clay Industries of New York. 174p. 2pl. map. Mar. 1895. 30*c*.

Eg6 (15) Merrill, F. J. H. Mineral Resources of New York. 224p. 2 maps. Sep. 1895. [50*c*]

Eg7 (17) —— Road Materials and Road Building in New York. 52p. 14pl. 2 maps 34x45, 68x92 cm. Oct. 1897. 15*c*.

Eg8 (30) Orton, Edward. Petroleum and Natural Gas in New York. 136p. il. 3 maps. Nov. 1899. 15*c*.

Eg9 (35) Ries, Heinrich. Clays of New York; their Properties and Uses. 456p. 140pl. map. June 1900. $1, *cloth*.

Eg10 (44) —— Lime and Cement Industries of New York; Eckel, E. C. Chapters on the Cement Industry. 332p. 101pl. 2 maps. Dec. 1901. 85*c*, *cloth*.

Eg11 (61) Dickinson, H. T. Quarries of Bluestone and other Sandstones in New York. 108p. 18pl. 2 maps. Mar. 1903. 35*c*.

Eg12 (85) Rafter, G. W. Hydrology of New York State. 902p. il. 44pl. 5 maps. May 1905. $1.50, *cloth*.

Eg13 (93) Newland, D. H. Mining and Quarry Industry of New York. 78p. July 1905. 15*c*.

Eg14 (100) McCourt, W. E. Fire Tests of Some New York Building Stones. 40p. 26pl. Feb. 1906. 15*c*.

Eg15 (102) Newland, D. H. Mining and Quarry Industry of New York. 2d Report. 162p. June 1906. 25*c*.

Eg16 (112) Mining and Quarry Industry 1906. 82p. July 1907. 15*c*.

Newland, D. H. & Hartnagel, C. A. The Sandstones of New York. *In preparation.*

Mineralogy. M1 (4) Nason, F. L. Some New York Minerals and their Localities. 20p. 1pl. Aug. 1888. [10*c*]

M2 (58) Whitlock, H. P. Guide to the Mineralogic Collections of the New York State Museum. 150p. il. 39pl. 11 models. Sep. 1902. 40*c*.

M3 (70) —— New York Mineral Localities. 110p. Sep. 1903. 20*c*.

M4 (98) —— Contributions from the Mineralogic Laboratory. 38p. 7pl. Dec. 1905. 15*c*.

Paleontology. Pa1 (34) Cumings, E. R. Lower Silurian System of Eastern Montgomery County; Prosser, C. S. Notes on the Stratigraphy of Mohawk Valley and Saratoga County, N. Y. 74p. 10pl. map. May 1900. 15*c*.

Pa2 (39) Clarke, J. M.; Simpson, G. B. & Loomis, F. B. Paleontologic Papers 1. 72p. il. 16 pl. Oct. 1900. 15*c*.

Contents: Clarke, J. M. A Remarkable Occurrence of Orthoceras in the Oneonta Beds of the Chenango Valley, N. Y.
—— Paropsonema cryptophya; a Peculiar Echinoderm from the Intumescens-zone (Portage Beds) of Western New York.
—— Dictyonine Hexactinellid Sponges from the Upper Devonic of New York.
—— The Water Biscuit of Squaw Island, Canandaigua Lake, N. Y.
Simpson, G. B. Preliminary Descriptions of New Genera of Paleozoic Rugose Corals.
Loomis, F. B. Siluric Fungi from Western New York.

Pa3 (42) Ruedemann, Rudolf. Hudson River Beds near Albany and their Taxonomic Equivalents. 114p. 2pl. map. Ap. 1901. 25*c*.

Pa4 (45) Grabau, A. W. Geology and Paleontology of Niagara Falls and Vicinity. 286p. il. 18pl. map. Ap. 1901. 65*c*; *cloth*, 90*c*.

Pa5 (49) Ruedemann, Rudolf; Clarke, J. M. & Wood, Elvira. Paleontologic Papers 2. 240p. 13pl. Dec. 1901. 40*c*.

Contents: Ruedemann, Rudolf. Trenton Conglomerate of Rysedorph Hill.
Clarke, J. M. Limestones of Central and Western New York Interbedded with Bituminous Shales of the Marcellus Stage.
Wood, Elvira. Marcellus Limestones of Lancaster, Erie Co. N. Y.
Clarke, J. M. New Agelacrinites.
—— Value of Amnigenia as an Indicator of Fresh-water Deposits during the Devonic of New York, Ireland and the Rhineland.

Pa6 (52) Clarke, J. M. Report of the State Paleontologist 1901. 280p. il. 9pl. map, 1 tab. July 1902. 40*c*.

Pa7 (63) —— Stratigraphy of Canandaigua and Naples Quadrangles. 78p. map. June 1904. 25*c*.

Pa8 (65) —— Catalogue of Type Specimens of Paleozoic Fossils in the New York State Museum. 848p. May 1903. $1.20, *cloth*.

Pa9 (69) —— Report of the State Paleontologist 1902. 464p. 52pl. 8 maps. Nov. 1903. $1, *cloth.*

Pa10 (80) —— Report of the State Paleontologist 1903. 396p. 20pl. map. Feb. 1905. 85c, *cloth.*

Pa11 (81) —— & Luther, D. D. Watkins and Elmira Quadrangles. 32p. map. Mar. 1905. 25c.

Pa12 (82) —— Geologic Map of the Tully Quadrangle. 40p. map. Ap. 1905. 20c.

Pa13 (92) Grabau, A. W. Guide to the Geology and Paleontology of the Schoharie Region. 316p. il. 24pl. map. Ap. 1906. 75c, *cloth.*

Pa14 (90) Ruedemann, Rudolf. Cephalopoda of Beekmantown and Chazy Formations of Champlain Basin. 226p. il. 38pl. Ap. 1906. 75c, *cloth.*

Pa15 (99) Luther, D. D. Geology of the Buffalo Quadrangle. 32p. map. May 1906. 20c.

Pa16 (101) —— Geology of the Penn Yan-Hammondsport Quadrangles. 28p. map. July 1906. 25c.

White, David. The Devonic Plants of New York. *In preparation.*

Hartnagel, C. A. Geology of the Rochester Quadrangle. *In press.*

Luther, D. D. Geology of the Geneva Quadrangle. *In preparation.*

—— Geology of the Ovid Quadrangle. *In preparation.*

—— Geology of the Phelps Quadrangle. *In preparation.*

Whitnall, H. O. Geology of the Morrisville Quadrangle. *Prepared.*

Hopkins, T. C. Geology of the Syracuse Quadrangle. *In preparation.*

Hudson, G. H. Geology of Valcour Island. *In preparation.*

Zoology. Z1 (1) Marshall, W. B. Preliminary List of New York Unionidae. 20p. Mar. 1892. 5c.

Z2 (9) —— Beaks of Unionidae Inhabiting the Vicinity of Albany, N. Y. 24p. 1pl. Aug. 1890. 10c.

Z3 (29) Miller, G. S. jr. Preliminary List of New York Mammals. 124p. Oct. 1899. 15c.

Z4 (33) Farr, M. S. Check List of New York Birds. 224p. Ap. 1900. 25c.

Z5 (38) Miller, G. S. jr. Key to the Land Mammals of Northeastern North America. 106p. Oct. 1900. 15c.

Z6 (40) Simpson, G. B. Anatomy and Physiology of Polygyra albolabris and Limax maximus and Embryology of Limax maximus. 82p. 28pl. Oct. 1901. 25c.

Z7 (43) Kellogg, J. L. Clam and Scallop Industries of New York. 36p. 2pl. map. Ap. 1901. 10c.

Z8 (51) Eckel, E. C. & Paulmier, F. C. Catalogue of Reptiles and Batrachians of New York. 64p. il. 1pl. Ap. 1902. 15c.

Eckel, E. C. Serpents of Northeastern United States.
Paulmier, F. C. Lizards, Tortoises and Batrachians of New York.

Z9 (60) Bean, T. H. Catalogue of the Fishes of New York. 784p. Feb. 1903. $1, *cloth.*

Z10 (71) Kellogg, J. L. Feeding Habits and Growth of Venus mercenaria. 30p. 4pl. Sep. 1903. 10c.

Z11 (88) Letson, Elizabeth J. Check List of the Mollusca of New York. 114p. May 1905. 20c.

Z12 (91) Paulmier, F. C. Higher Crustacea of New York City. 78p. il. June 1905. 20c.

Entomology. En 1 (5) Lintner, J. A. White Grub of the May Beetle. 32p. il. Nov. 1888. 10c.

En2 (6) —— Cut-worms. 36p. il. Nov. 1888. 10c.

En3 (13) —— San José Scale and Some Destructive Insects of New York State. 54p. 7pl. Ap. 1895. 15c.

En4 (20) Felt, E. P. Elm-leaf Beetle in New York State. 46p. il. 5pl. June 1898. 5c.

See En15.

En5 (23) —— 14th Report of the State Entomologist 1898. 150p. il. 9pl. Dec. 1898. 20c.

En6 (24) —— Memorial of the Life and Entomologic Work of J. A. Lintner Ph.D. State Entomologist 1874–98; Index to Entomologist's Reports 1–13. 316p. 1pl. Oct. 1899. 35c.

Supplement to 14th report of the State Entomologist.

En7 (26) —— Collection, Preservation and Distribution of New York Insects. 36p. il. Ap. 1899. 5*c.*

En8 (27) —— Shade Tree Pests in New York State. 26p. il. 5pl. May 1899. 5*c.*

En9 (31) —— 15th Report of the State Entomologist 1899. 128p. June 1900. 15*c.*

En10 (36) —— 16th Report of the State Entomologist 1900. 118p. 16pl. Mar. 1901. 25*c.*

En11 (37) —— Catalogue of Some of the More Important Injurious and Beneficial Insects of New York State. 54p. il. Sep. 1900. 10*c.*

En12 (46) —— Scale Insects of Importance and a List of the Species in New York State. 94p. il. 15pl. June 1901. 25*c.*

En13 (47) Needham, J. G. & Betten, Cornelius. Aquatic Insects in the Adirondacks. 234p. il. 36pl. Sep. 1901. 45*c.*

En14 (53) Felt, E. P. 17th Report of the State Entomologist 1901. 232p. il. 6pl. Aug. 1902. *Out of print.*

En15 (57) —— Elm Leaf Beetle in New York State. 46p. il. 8pl. Aug. 1902. *Out of print.*

This is a revision of En4 containing the more essential facts observed since that was prepared.

En16 (59) —— Grapevine Root Worm. 40p. 6pl. Dec. 1902. 15*c.*

See En19.

En17 (64) —— 18th Report of the State Entomologist 1902. 110p. 6pl. May 1903. 20*c.*

En18 (68) Needham, J. G. *& others.* Aquatic Insects in New York. 322p. 52pl. Aug. 1903. 80*c, cloth.*

En19 (72) Felt, E. P. Grapevine Root Worm. 58p. 13pl. Nov. 1903. 20*c.*

This is a revision of En16 containing the more essential facts observed since that was prepared.

En20 (74) —— & Joutel, L. H. Monograph of the Genus Saperda. 88p. 14pl. June 1904. 25*c.*

En21 (76) Felt, E. P. 19th Report of the State Entomologist 1903. 150p. 4pl. 1904. 15*c.*

En22 (79) —— Mosquitos or Culicidae of New York. 164p. il. 57pl. Oct. 1904. 40*c.*

En23 (86) Needham, J. G. *& others.* May Flies and Midges of New York. 352p. il. 37pl. June 1905. 80*c, cloth.*

En24 (97) Felt, E. P. 20th Report of the State Entomologist 1904. 246p. il. 19pl. Nov. 1905. 40*c.*

En25 (103) —— Gipsy and Brown Tail Moths. 44p. 10pl. July 1906. 15*c.*

En26 (104) —— 21st Report of the State Entomologist 1905. 144p. 10pl. Aug. 1906. 25*c.*

En27 (109) —— Tussock Moth and Elm Leaf Beetle. 34p. 8pl. Mar. 1907. 20*c.*

En28 (110) —— 22d Report of the State Entomologist 1906. 152p. 3pl. June 1907. 25*c.*

Needham, J. G. Monograph on Stone Flies. *In preparation.*

Botany. Bo1 (2) Peck, C. H. Contributions to the Botany of the State of New York. 66p. 2pl. May 1887. *Out of print.*

Bo2 (8) —— Boleti of the United States. 96p. Sep. 1889. [50*c*]

Bo3 (25) —— Report of the State Botanist 1898. 76p. 5pl. Oct. 1899. *Out of print.*

Bo4 (28) —— Plants of North Elba. 206p. map. June 1899. 20*c.*

Bo5 (54) —— Report of the State Botanist 1901. 58p. 7pl. Nov. 1902. 40*c.*

Bo6 (67) —— Report of the State Botanist 1902. 196p. 5pl. May 1903. 50*c.*

Bo7 (75) —— Report of the State Botanist 1903. 70p. 4pl. 1904. 40*c.*

Bo8 (94) —— Report of the State Botanist 1904. 60p. 10pl. July 1905. 40*c.*

Bo9 (105) —— Report of the State Botanist 1905. 108p. 12pl. Aug. 1906. 50*c.*

Bo 10 (116) —— Report of the State Botanist 1906. *In press.*

Archeology. Ar1 (16) Beauchamp, W. M. Aboriginal Chipped Stone Implements of New York. 86p. 23pl. Oct. 1897. 25*c.*

Ar2 (18) —— Polished Stone Articles used by the New York Aborigines. 104p. 35pl. Nov. 1897. 25*c.*

Ar3 (22) —— Earthenware of the New York Aborigines. 78p. 33pl. Oct. 1898. 25*c.*

Ar4 (32) —— Aboriginal Occupation of New York. 190p. 16pl. 2 maps. Mar. 1900. 30*c.*

Ar5 (41) —— Wampum and Shell Articles used by New York Indians. 166p. 28pl. Mar. 1901. 30*c*.

Ar6 (50) —— Horn and Bone Implements of the New York Indians. 112p. 43pl. Mar. 1902. 30*c*.

Ar7 (55) —— Metallic Implements of the New York Indians. 94p. 38pl. June 1902. 25*c*.

Ar8 (73) —— Metallic Ornaments of the New York Indians. 122p. 37pl. Dec. 1903. 30*c*.

Ar9 (78) —— History of the New York Iroquois. 340p. 17pl. map. Feb. 1905. 75*c*, *cloth*.

Ar10 (87) —— Perch Lake Mounds. 84p. 12pl. Ap. 1905. 20*c*.

Ar11 (89) —— Aboriginal Use of Wood in New York. 190p. 35pl. June 1905. 35*c*.

Ar12 (108) —— Aboriginal Place Names of New York. 336p. May 1907. 40*c*.

Ar13 (113) —— Civil, Religious and Mourning Councils and Ceremonies of Adoption. 118p. 7pl. June 1907. 25*c*.

Miscellaneous. Ms1 (62) Merrill, F. J. H. Directory of Natural History Museums in United States and Canada. 236p. Ap. 1903. 30*c*.

Ms2 (66) Ellis, Mary. Index to Publications of the New York State Natural History Survey and New York State Museum 1837–1902. 418p. June 1903. 75*c*, *cloth*.

Museum memoirs 1889–date. Q.

1 Beecher, C. E. & Clarke, J. M. Development of Some Silurian Brachiopoda. 96p. 8pl. Oct. 1889. $1.

2 Hall, James & Clarke, J. M. Paleozoic Reticulate Sponges. 350p. il. 70pl. 1898. $1, *cloth*.

3 Clarke, J. M. The Oriskany Fauna of Becraft Mountain, Columbia Co. N. Y. 128p. 9pl. Oct. 1900. 80*c*.

4 Peck, C. H. N. Y. Edible Fungi, 1895–99. 106p. 25pl. Nov. 1900. 75*c*.

This includes revised descriptions and illustrations of fungi reported in the 49th, 51st and 52d reports of the State Botanist.

5 Clarke, J. M. & Ruedemann, Rudolf. Guelph Formation and Fauna of New York State. 196p. 21pl. July 1903. $1.50, *cloth*.

6 Clarke, J. M. Naples Fauna in Western New York. 268p. 26pl. map. $2, *cloth*.

7 Ruedemann, Rudolf. Graptolites of New York. Pt 1 Graptolites of the Lower Beds. 350p. 17pl. Feb. 1905. $1.50, *cloth*.

8 Felt, E. P. Insects Affecting Park and Woodland Trees. v.1 460p. il. 48pl. Feb. 1906. $2.50, *cloth*. v.2 548p. il. 22pl. Feb. 1907. $2, *cloth*.

9 Clarke, J. M. Early Devonic of New York and Eastern North America. *In press*.

10 Eastman, C. R. The Devonic Fishes of the New York Formations. 236p. 15pl. 1907. $1.25 *cloth*.

Eaton, E. H. Birds of New York. *In preparation*.

Ruedemann, R. Graptolites of New York. Pt 2 Graptolites of the Higher Beds. *In press*.

Natural history of New York. 30v. il. pl. maps. Q. Albany 1842–94.

DIVISION 1 ZOOLOGY. De Kay, James E. Zoology of New York; or, The New York Fauna; comprising detailed descriptions of all the animals hitherto observed within the State of New York with brief notices of those occasionally found near its borders, and accompanied by appropriate illustrations. 5v. il. pl. maps. sq. Q. Albany 1842–44. *Out of print*.

Historical introduction to the series by Gov. W. H. Seward. 178p.

v. 1 pt1 Mammalia. 131+46p. 33pl. 1842.

300 copies with hand-colored plates.

v. 2 pt2 Birds. 12+380p. 141pl. 1844.

Colored plates.

v. 3 pt3 Reptiles and Amphibia. 7+98p. pt4 Fishes. 15+415p. 1842.

pt3–4 bound together.

v. 4 Plates to accompany v. 3. Reptiles and Amphibia 23pl. Fishes 79pl. 1842.

300 copies with hand-colored plates.

v. 5 pt5 Mollusca. 4+271p. 40pl. pt6 Crustacea. 70p. 13pl. 1843–44.

Hand-colored plates; pt5–6 bound together.

82

Published monthly by the
New York State Education Department
BULLETIN 405 JULY 1907

New York State Museum

JOHN M. CLARKE, Director

Bulletin 112

ECONOMIC GEOLOGY 16

THE MINING AND QUARRY INDUSTRY

OF

NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTIONS DURING 1906

BY

D. H. NEWLAND

	PAGE
Preface	5
Introduction	6
Mineral production of New York in 1904	8
Mineral production of New York in 1905	9
Mineral production of New York in 1906	10
Arsenical ore	10
Carbon dioxid	12
Cement	13
Clay	14
Manufacture of building brick	18
Other clay materials	21
New manufacturers of clay materials	21
Pottery	22
Crude clay	24
Emery	24
Feldspar	24
Garnet	25
Graphite	26
Gypsum	27
Iron ore	29
Notes on recent mining developments	31
Millstones	43
Mineral paint	44
Natural gas	46
Peat	49
Petroleum	50
Pyrite	52
Quartz	52
Salt	53
Sand-lime brick	55
Slate	56
Stone	57
Granite	59
Limestone	60
Marble	64
Sandstone	66
Trap	68
Talc	70
Zinc and lead	71
Index	73

ALBANY
NEW YORK STATE EDUCATION DEPARTMENT
1907

Price 15 cents

M183m-Ap7-2000

Collected set.

Q11 N82

STATE OF NEW YORK

EDUCATION DEPARTMENT

Regents of the University

With years when terms expire

1913	WHITELAW REID M.A. LL.D. *Chancellor*	New York
1917	ST CLAIR MCKELWAY M.A. LL.D. *Vice Chancellor*	Brooklyn
1908	DANIEL BEACH Ph.D. LL.D.	Watkins
1914	PLINY T. SEXTON LL.B. LL.D.	Palmyra
1912	T. GUILFORD SMITH M.A. C.E. LL.D.	Buffalo
1918	WILLIAM NOTTINGHAM M.A. Ph.D. LL.D.	Syracuse
1910	CHARLES A. GARDINER Ph.D. L.H.D. LL.D. D.C.L.	New York
1915	ALBERT VANDER VEER M.D. M.A. Ph.D. LL.D.	Albany
1911	EDWARD LAUTERBACH M.A. LL.D.	New York
1909	EUGENE A. PHILBIN LL.B. LL.D.	New York
1916	LUCIAN L. SHEDDEN LL.B.	Plattsburg

Commissioner of Education

ANDREW S. DRAPER LL.B. LL.D.

Assistant Commissioners

HOWARD J. ROGERS M.A. LL.D. *First Assistant*
EDWARD J. GOODWIN Lit.D. L.H.D. *Second Assistant*
AUGUSTUS S. DOWNING M.A. Pd.D. LL.D. *Third Assistant*

Secretary to the Commissioner

HARLAN H. HORNER B.A.

Director of State Library

EDWIN H. ANDERSON M.A.

Director of Science and State Museum

JOHN M. CLARKE Ph.D. LL.D.

Chiefs of Divisions

Accounts, WILLIAM MASON
Attendance, JAMES D. SULLIVAN
Educational Extension, WILLIAM R. EASTMAN M.A. B.L.S.
Examinations, CHARLES F. WHEELOCK B.S. LL.D.
Inspections, FRANK H. WOOD M.A.
Law, THOMAS E. FINEGAN M.A.
School Libraries, CHARLES E. FITCH L.H.D.
Statistics, HIRAM C. CASE
Visual Instruction, DE LANCEY M. ELLIS

New York State Education Department
Science Division, April 16, 1907

Hon. Andrew S. Draper LL.D.
Commissioner of Education

My dear sir: I communicate herewith for publication as a bulletin of the State Museum, the third annual report on *The Mining and Quarry Industry of New York State* prepared by the Assistant State Geologist.

The public demand for these publications is urgent and I suggest that the printing of this report be forwarded without delay.

Very respectfully yours
John M. Clarke
Director

State of New York
Education Department
COMMISSIONER'S ROOM

Approved for publication this 18th day of April 1907

A. S. Draper
Commissioner of Education

New York State Education Department

New York State Museum

JOHN M. CLARKE, Director

Bulletin 112

ECONOMIC GEOLOGY 16

THE MINING AND QUARRY INDUSTRY

OF

NEW YORK STATE

REPORT OF OPERATIONS AND PRODUCTION DURING 1906

BY

D. H. NEWLAND

PREFACE

The present bulletin — the third of the series to bear the same title — carries forward the plan of issuing a report each year on the mineral industry of New York. The series is intended to afford a summary of the current discoveries, developments and production of the useful mineral materials, each volume being prepared as soon after the close of the year as practicable. With this report the information is brought down to the end of 1906.

It is desired again to express grateful acknowledgment for the assistance rendered by those engaged in mining and quarry enterprises within the State; the requests for information have met with a uniform consideration on their part which has greatly facilitated the preparation of the report.

INTRODUCTION

The mineral industries of New York have continued to experience during the past year the conditions of general prosperity and advancement noticed in the previous report for 1905. A summary of the returns received from producers distributed among the different branches which are represented in the State shows a valuation for the year's output of $37,118,430. The total takes into account over 30 mineral materials that are commercially exploited. It is to be noted, however, that the valuation is placed upon the materials in their crude or first marketable forms, and no attempt has been made to obtain information relative to the many and varied industries which derive their support from further elaboration of the materials.

The corresponding total reported in 1905 was $35,470,987. In 1904 the value amounted to $28,812,595. The gain for the past year was $1,647,443 or about 5 per cent, while during the two previous years for which statistics have been collected the increase has been $8,305,835 or nearly 30 per cent.

The progress of the iron-mining industry has been one of the notable features of the year's record. The output amounted to 905,367 long tons, the largest reported since 1891, and an increase of 78,318 tons over that for 1905. There were 11 mines in the State under exploitation, the number including three which began production during the year. Exploratory developments have been carried on by several additional companies as a preliminary to active mining. The Fair Haven Iron Co. will begin shipments in the spring from its mine situated at Sterling Station, Cayuga co. The Benson mines in St Lawrence county, the Cheever mine in Essex county and the Salisbury mine in Herkimer county have been under development. The opening of the Lake Sanford titaniferous magnetite deposits, which have recently been transferred to new ownership, is perhaps the most important prospective feature to be recorded in the mining of iron ore.

The manufacture of clay products contributed an aggregate value of $13,955,300 in 1906 as compared with $14,280,016 in the preceding year. The decrease was due principally to the lower prices obtained for structural materials. The output of clay building materials (brick, tile, fireproofing and terra cotta) was valued at $11,063,433. The number of brick made was 1,600,059,000, of which 1,230,692,000 was reported by the plants along the Hudson river. Pottery is a growing branch of the clay-working industry;

its share in the total last year amounted to $1,795,008 represented mostly by the finer wares, porcelain and semiporcelain. There were 265 clay-working plants in operation distributed among 48 counties.

There was little change in the valuation of the products reported by the quarries, the total for 1906 amounting to $6,504,165 against $6,107,147 in the preceding year. The sum was divided according to the various uses into: building stone $1,408,583; monumental stone $103,219; curbing and flagging $999,678; crushed stone $2,435,493; other uses $1,557,192. The output of slate and of limestone used in making Portland and natural cements is not included in the totals.

The plants manufacturing hydraulic cement reported a production of 4,114,939 barrels, consisting of 2,423,374 barrels of Portland cement and 1,691,565 barrels of natural rock cement. There was a large falling off in the natural rock cement, owing to conditions that have developed generally in the cement trade, and for the first time the total was exceeded by that of Portland cement. The combined value of the production was $3,950,699. In 1905 the output amounted to 4,375,520 barrels valued at $3,673,553.

In the salt industry the production has been maintained at an unusually high rate. The total of rock and brine salt reported was 9,013,993 barrels, which is the largest on record. The output for the preceding year amounted to 8,575,649 barrels. There was a slight decrease in the market value — $2,131,650, as compared with $2,303,067 in 1905. A large portion of the brine salt made in New York is used for the manufacture of soda products.

The mines and quarries of gypsum made an output of 262,581 short tons, valued at $685,053. There was a large gain over the previous year when the production amounted to 191,860 tons, valued at $551,193. The increase came mostly from the companies manufacturing wall plaster and plaster of paris.

The combined value of the petroleum and natural gas produced in the State was $2,487,674, against $2,173,931 in 1905. The quantity of petroleum reported was 1,043,088 barrels valued at $1,721,095, or a little more than in the preceding year. The natural gas industry continues to show progress, due to the active developments in Erie and Chautauqua counties. The quantity of gas reported last year was 3,007,086,000 cubic feet, against 2,639,130,000 cubic feet, the total for 1905.

Among the smaller industries which have a firm foothold in New York State are the mining of garnet, graphite and talc. The garnet product in 1906 amounted to 4729 short tons, valued at $159,298. The graphite produced was 2,811,582 pounds, valued at $96,084. The talc mines reported an output of 64,200 short tons, with a valuation of $541,600.

Mineral production of New York in 1904

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	1 377 302	$1 245 778
Natural rock cement	Barrels	1 881 630	1 207 883
Building brick	Thousands	1 293 538	7 473 122
Pottery	....	....	1 438 634
Other clay products	....	....	2 592 948
Crude clay	Short tons	8 959	17 164
Emery	Short tons	1 148	17 220
Feldspar and quartz	Long tons	8 703	28 463
Garnet	Short tons	3 045	104 325
Glass sand	Short tons	11 080	8 484
Graphite	Pounds	3 132 927	119 509
Gypsum	Short tons	151 455	424 975
Iron ore	Long tons	619 103	1 328 894
Millstones	....	....	21 476
Metallic paint	Short tons	4 740	55 768
Slate pigment	Short tons	3 132	23 876
Mineral waters	Gallons	8 000 000	1 000 000
Natural gas	1000 cubic feet	2 399 987	552 197
Petroleum	Barrels	1 036 179	1 709 770
Pyrite	Long tons	5 275	20 820
Salt	Barrels	8 724 768	2 102 748
Roofing slate	Squares	18 090	86 159
Slate manufactures	....	....	7 441
Granite	....	....	221 882
Limestone	....	....	2 104 095
Marble	....	....	478 771
Sandstone	....	....	1 896 697
Trap	....	....	468 496
Talc	Short tons	65 000	455 000
Other materials[a]	....	....	1 600 000
Total value	....	....	$28 812 595

---

[a] Includes apatite, carbon dioxid, diatomaceous earth, fullers earth, marl and sand. The value is partly estimated.

Mineral production of New York in 1905

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	2 117 822	$2 046 864
Natural rock cement	Barrels	2 257 698	1 590 689
Building brick	Thousands	1 512 157	10 054 597
Pottery			1 620 558
Other clay products			2 603 861
Crude clay	Short tons	6 766	16 616
Emery	Short tons	1 475	12 452
Feldspar and quartz	Long tons	17 000	48 500
Garnet	Short tons	2 700	94 500
Glass sand	Short tons	9 850	7 765
Graphite	Pounds	3 897 616	142 948
Gypsum	Short tons	191 860	551 193
Iron ore	Long tons	827 049	2 576 123
Millstones			22 944
Metallic paint	Short tons	6 059	70 090
Slate pigment	Short tons	2 929	22 668
Mineral waters	Gallons	8 000 000	1 000 000
Natural gas	1000 cubic feet	2 639 130	607 000
Petroleum	Barrels	949 511	1 566 931
Pyrite	Long tons	10 100	40 465
Salt	Barrels	8 575 649	2 303 067
Roofing slate	Squares	16 460	94 009
Slate manufactures			1 000
Granite			253 955
Limestone			2 411 456
Marble			774 557
Sandstone			2 043 960
Trap			623 219
Talc	Short tons	67 000	469 000
Other materials[a]			1 800 000
Total value			$35 470 987

---

[a] Includes apatite, carbon dioxid, diatomaceous earth, fullers earth, marl, sand and sand lime brick. The value is partly estimated.

Mineral production of New York in 1906

PRODUCT	UNIT OF MEASUREMENT	QUANTITY	VALUE
Portland cement	Barrels	2 423 374	$2 766 488
Natural rock cement	Barrels	1 691 565	1 184 211
Building brick	Thousands	1 600 059	9 688 289
Pottery			1 795 008
Other clay products			2 472 003
Crude clay	Short tons	5 477	9 125
Emery	Short tons	1 307	13 870
Feldspar and quartz	Long tons	13 660	44 350
Garnet	Short tons	4 729	159 298
Glass sand	Short tons	9 000	8 600
Graphite	Pounds	2 811 582	96 084
Gypsum	Short tons	262 581	685 053
Iron ore	Long tons	905 367	3 393 609
Millstones			22 442
Metallic paint	Short tons	2 714	29 140
Slate pigment	Short tons	2 045	15 960
Mineral waters	Gallons	8 000 000	1 000 000
Natural gas	1000 cubic feet	3 007 086	766 579
Petroleum	Barrels	1 043 088	1 721 095
Pyrite	Long tons	11 798	35 550
Salt	Barrels	9 013 993	2 131 650
Roofing slate	Squares	16 248	57 771
Slate manufactures			4 150
Sand lime brick	Thousands	17 080	122 340
Granite			255 189
Limestone			2 963 829
Marble			460 915
Sandstone			1 976 829
Trap			847 403
Talc	Short tons	64 200	541 600
Other materials[a]			1 850 000
Total value			$37 118 430

[a] Includes apatite, arsenical ore, carbon dioxid, diatomaceous earth, fullers earth, marl, and sand and gravel exclusive of glass sand.

ARSENICAL ORE

Several hundred tons of arsenical ore were mined in New York State last year. A part of the output was sold to reduction works for manufacture into arsenical compounds. Though deposits of this ore have been worked previously in the State, it is probably the first time that they have supplied any commercial product.

The ores known to occur in New York include arsenopyrite, leucopyrite and scorodite. The first named, a sulfarsenid of iron with 46% arsenic, is the most abundant. It is also the principal variety employed in the trade. It occurs in Orange, Putnam and Essex counties, in veins which intersect the older crystalline rocks.

The deposit which has been under operation during 1906, is situated near Pine pond, town of Kent, Putnam co. It has been known for many years and was the object of exploration as early as 1847. The operations were abandoned, however, after a little preliminary work. In 1888 a small quantity of ore was mined and shipped to New Jersey, evidently for other purposes than the utilization of the arsenic as no plant for treating the ore is located in that state. The present company, the Putnam County Mining Corporation, undertook the development of the property in April, 1906. Of the ore that has been mined, a portion amounting to a few hundred tons was found to contain sufficient arsenic to be shipped in crude condition and was sold to metallurgical establishments abroad. The low grade ore has been held in stock with a view to future concentration, for which a special plant will have to be built.

So far as revealed by existing developments, the deposit appears to be a vein-intersecting gneiss which is the prevailing formation in this section and includes both igneous and sedimentary varieties. The vein lies near the base of a prominent ridge, southwest of Pine pond. It has a northerly strike. In close proximity and running parallel is a dike of basic rock, the outcropping portion of which is completely changed to serpentine. The dike rises above the surface as a distinct ridge that can be traced for half a mile or more along the strike and shows a width of from 100 to 300 yards. It is probably a peridotite, though the nature of the original components can only be inferred from the general appearance and texture.

The vein consists of white flinty quartz with varying proportions of arsenopyrite and pyrite. In places the metallic minerals occur in solid mass, but usually they are distributed through the quartz. Pyrite is much less abundant of the two, its distribution being very irregular. Both are seldom crystallized. The percentage of metallic arsenic in the ore ranges nearly up to the theoretical amount required by the chemical formula. With hand sorting a fairly large proportion will assay above 25% which is considered marketable grade. For the following complete analysis of the ore the writer is indebted to Mr George Wishart, manager of the mine.

Silica (SiO_2)	2.90
Iron (Fe)	36.11
Copper (Cu)	2.17
Sulfur (S)	22.72
Arsenic (As)	36.00
	99.90

The copper shown by the analysis is probably present in the pyrite. This mineral usually has the deep yellow color characteristic of the copper-bearing variety.

An analysis of the dike, which has also been reported by Mr Wishart, is sufficiently interesting to deserve record. It establishes the ultra-basic nature of the rock and is in agreement with the view above expressed that it is an altered peridotite.

Silica (SiO_2)	35.50
Alumina (Al_2O_3)	4.52
Ferric oxid (Fe_2O_3)	7.40
Lime (CaO)	2.60
Magnesia (MgO)	37.64
Carbon dioxid (CO_2) Water (H_2O)	13.30
	100.96

Arsenopyrite has been reported by Beck[1] and Whitlock[2] near Edenville and at other places in Orange county and in the town of Lewis, Essex co., 10 miles south of Keeseville. At the first named locality it is associated with leucopyrite, the disarsenid of iron and scorodite, a hydrous arsenate of iron; the wall rock is crystalline limestone.

CARBON DIOXID

The production of natural carbonic acid gas as an industry is confined to the vicinity of Saratoga Springs. There are no other localities in this country where the gas is recovered from natural sources and marketed, though a large production is made by the decomposition of mineral carbonates, combustion of coke and in other ways.

The companies engaged in this industry at Saratoga Springs include the following: New York Carbonic Acid Gas Co., Natural Carbonic Gas Co., Lincoln Spring Co., Geysers Natural Carbonic Acid Gas Co., and the Champion Natural Carbonic Acid Gas Co.

The phenomena of occurrence and the methods used in collecting and storage of the gas for market have been described in the preceding issue of this publication. There have been no new features in the industry during the past year, except that the production has increased about 25 per cent. According to an estimate made by J. C. Minor jr, the quantity recovered was about 5,000,000 pounds, compared with 4,000,000 pounds in 1905. The gain has been due rather to the perfection of the methods for saving the gas than to drilling of additional wells.

---

[1] Mineralogy of New York. 1842.

[2] List of New York Mineral Localities, N. Y. State Mus. Bul. 70. 1903.

CEMENT

The conditions in the cement industry were, on the whole, very favorable during the past year. There was an unusual demand for cement within the State, due to the general activity of building and construction and specially to the carrying out of important engineering undertakings in connection with the canal system and the railroad terminals of New York city. As a consequence the companies were able to market their entire output for the year without difficulty. The prices have also been higher than for some time past.

In all there were 19 firms that reported a production in 1906, as compared with 21 firms similarly reporting in the previous year. The combined output of Portland and natural rock cement amounted to 4,114,939 barrels valued at $3,950,699. In 1905 the output was 4,375,520 barrels valued at $3,673,553, so that there was a loss for the year of 260,581 barrels in the quantity produced, but a gain of $277,196 in the value. The decreased production was brought about by the conditions incidental to the natural rock cement trade which has lost a good deal of its former importance in this State as elsewhere.

The output of Portland cement amounted to 2,423,374 barrels valued at $2,766,488 against 2,117,822 barrels valued at $2,046,864 in 1905. There were 10 companies in operation, a gain of one for the year. The Cummings Cement Co., at Akron, Erie co., which had closed down its plant for repairs and new machinery, was again productive. The company makes both Portland and natural rock cement. Important improvements have been made in the plant of the Glens Falls Cement Co., including the installation of rotary kilns in the place of upright kilns.

The production of natural rock cement amounted to 1,691,565 barrels valued at $1,184,211. In 1905 the total was 2,257,698 barrels valued at $1,590,689. As heretofore the Rosendale district has contributed most of the output, its share having been 1,514,336 barrels with a value of $1,107,535. In 1905 this district produced 1,977,698 barrels valued at $1,472,489. Onondaga county reported a total of 63,043 barrels valued at $30,923, against 77,000 barrels

$166,645 against $146,790; and sewer pipe to $95,142, against $444,457. The product of terra cotta was valued at $1,037,387, as compared with $874,717 in 1905; fireproofing at $120,282, as compared with $133,995; and building tile at $217,475, as compared with $251,600. In addition there were produced miscellaneous materials, including flue lining, fire tile and shapes, conduit pipes, sidewalk brick and acid-proof brick, the collected value of which amounted to $129,402, against $74,114 in 1905. The potteries of the State reported an output valued at $1,795,008, as compared with a value of $1,620,558 in the preceding year.

Production of clay materials

MATERIAL	1904	1905	1906
Common brick	$7 234 876	$9 751 753	$9 302 165
Front brick	238 246	302 844	386 124
Vitrified paving brick	210 707	180 004	178 011
Fire brick and stove lining	506 800	498 184	527 659
Drain tile	149 864	146 790	166 645
Sewer pipe	460 000	444 457	95 142
Terra cotta	798 028	874 717	1 037 387
Fireproofing	157 119	133 995	120 282
Building tile	206 503	251 600	217 475
Miscellaneous	103 927	75 114	129 402
Pottery	1 438 634	1 620 558	1 795 008
Total	$11 504 704	$14 280 016	$13 955 300

The distribution of the production according to the counties in which it was made shows that Rockland county has the largest clay-working industry. The value of its output in 1906 was $1,767,012. It also led the list of counties in 1905 with an aggregate value of $2,144,210. Ulster county ranks second in importance, its total being $1,465,457, as compared with $1,776,035 in the preceding year. Orange county, which was fourth in 1905, advanced to third place last year with a total of $1,170,695, against $1,011,006. Onondaga county ranks fourth with a value of $1,094,635, against $932,285, the greater part of its production being pottery. Dutchess county moved from third place in 1905, when it reported a value of $1,258,937, to fifth in 1906, with a valuation of $975,410. The other counties that reported a production valued at $100,000 or over in 1906 are: Richmond ($896,789); Erie ($804,159); Albany ($675,099); Kings ($575,973); Westchester ($536,189); Columbia

($489,750); Greene ($399,298); Saratoga ($388,450); Ontario ($343,040); Monroe ($341,870); Rensselaer ($296,762); Steuben ($209,052); Nassau ($163,700); Suffolk ($138,500); Allegany ($111,683); Oneida ($103,263); and Queens county, the total of which is withheld in order not to reveal the figures reported by the single producer.

Production of clay materials by counties

COUNTY	1904	1905	1906
Albany	$648 973	$624 238	$675 099
Allegany	127 552	118 989	111 683
Broome	22 000	18 000	12 000
Cayuga	24 520	25 920	17 860
Chautauqua	83 405	78 130	99 085
Chemung	96 300	96 000	90 000
Clinton	5 000	5 900	4 800
Columbia	420 500	520 500	489 750
Dutchess	932 907	1 258 937	975 410
Erie	647 334	700 527	804 159
Fulton	4 000	1 700	2 600
Greene	232 924	389 562	399 298
Jefferson	30 467	36 502	36 722
Kings	539 288	565 888	575 973
Madison	16 400	12 000	16 800
Monroe	658 058	644 411	341 870
Nassau	52 644	76 992	163 700
Niagara	16 892	3 272	10 832
Oneida	145 880	133 250	103 263
Onondaga	916 954	932 285	1 094 635
Ontario	245 743	345 250	343 040
Orange	690 064	1 011 006	1 170 695
Rensselaer	257 751	263 256	296 762
Richmond	488 873	645 367	896 789
Rockland	1 422 436	2 144 210	1 767 012
Saratoga	331 360	362 268	388 450
Seneca	19 175	3 525	39 525
Steuben	176 613	164 663	209 052
Suffolk	86 112	113 000	138 500
Tompkins	17 715	15 004	*a*..........
Ulster	1 274 284	1 776 035	1 465 457
Warren	28 625	45 712	34 500
Washington	15 755	20 270	22 033
Westchester	354 705	592 705	536 189
Other counties*b*	473 495	534 742	621 757
Total	704	$14 280 016	$13 955 300

a Included under "other coun

b Includes in 1905: Genesee, [illegible] k, Queens, St Lawrence, Schenectady, Wayne and Wyoming [illegible] ng counties are included: C[illegible] Genesee, Herkim[illegible] w York, Queens, St Law-
[illegible] dy, Tioga, To

Manufacture of building brick

The output of common building brick in 1906 amounted to 1,575,434,000, valued at $9,302,165. In addition there were made 24,625,000 front and fancy pressed brick, valued at $386,124; making an aggregate output of brick for building purposes of 1,600,059,000, valued at $9,688,289. The total quantity manufactured in the preceding year was 1,512,157,000, valued at $10,054,597, consisting of

Production of common building brick

COUNTY	1905		1906	
	Number	Value	Number	Value
Albany	66 500 000	$439 238	74 083 000	$461 399
Allegany	1 092 000	6 957	*a*...........	*a*........
Broome	3 000 000	18 000	2 000 000	12 000
Cayuga	3 416 000	21 520	2 215 000	13 310
Chautauqua	8 885 000	49 992	8 567 000	52 031
Chemung	15 600 000	96 000	15 000 000	90 000
Clinton	1 100 000	5 900	800 000	4 800
Columbia	84 750 000	520 500	84 500 000	489 750
Dutchess	181 683 000	1 258 937	167 132 000	975 410
Erie	54 269 000	282 859	56 302 000	319 365
Greene	55 719 000	377 470	64 690 000	390 748
Jefferson	4 900 000	36 502	5 100 000	36 722
Monroe	24 176 000	139 320	26 077 000	158 463
Nassau	8 240 000	58 872	22 000 000	125 000
Niagara	*a*..........	*a*........	2 172 000	10 832
Oneida	17 046 000	86 769	20 550 000	100 825
Onondaga	16 889 000	104 134	22 387 000	127 494
Ontario	3 000 000	18 000	3 510 000	21 700
Orange	160 530 000	1 011 006	189 180 000	1 170 695
Rensselaer	25 250 000	133 350	31 776 000	173 906
Richmond	*a*..........	*a*........	34 769 000	172 880
Rockland	302 625 000	2 144 210	296 145 000	1 767 012
St Lawrence	600 000	4 200	*a*...........	*a*........
Saratoga	62 335 000	319 569	70 509 000	385 950
Seneca	50 000	400	6 050 000	36 400
Steuben	2 000 000	21 300	4 705 000	31 800
Suffolk	17 250 000	110 000	21 710 000	137 500
Tompkins	2 021 000	15 004	*a*...........	*a*........
Ulster	265 368 000	1 776 035	252 665 000	1 465 457
Warren	8 763 000	45 712	*a*...........	*a*........
Washington	2 300 000	11 800	3 300 000	18 100
Westchester	76 893 000	530 465	70 621 000	458 000
Other counties*b*	17 209 000	107 732	16 919 000	94 606
Total	1 403 459 000	$9 751 753	1 575 434 000	$9 302 165

a Included under "other counties."

b Includes in 1905 the following: Fulton, Herkimer, Livingston, Montgomery, Richmond, Tioga and Wyoming. In 1906 the following counties are included: Allegany, Cattaraugus, Fulton, Herkimer, Livingston, Montgomery, St Lawrence, Schenectady, Tioga, Tompkins and Warren.

1,493,459,000 common brick, valued at $9,751,753 and 18,698,000 front and fancy bricks valued at $302,844. The manufacture of these materials was carried on in 37 counties by a total of 213 companies or individuals. In 1905 there were 39 counties represented with a total of 192 plants.

The average price received for common brick last year was $5.98 a thousand, as compared with $6.53 a thousand in 1905 and $5.67 a thousand the average for 1904. Front and fancy pressed brick averaged $15.68 a thousand against $16.20 in 1905 and $13.48 in 1904.

Hudson river region. The counties in New York State situated along the Hudson river are specially favored in respect to the manufacture of building brick. New York city and vicinity, with its rapidly increasing population, is by far the greatest market for such materials in the United States. There exist enormous clay deposits, suitable for making the common grades of brick, on either side of the river from Rensselaer and Albany counties down to Rockland and Westchester, while the river itself affords a convenient and cheap means of transportation direct from the yards to the market. As a result of these conditions the brick industry of this section has developed to proportions that are without parallel in any other part of the country.

In 1906 the output of common brick in the Hudson river region amounted to a total of 1,230,692,000. This is approximately 78 per cent of the whole output of common brick in the State. The value of the production was $7,352,377. In the preceding year the output was 1,219,318,000, valued at $8,191,211. There was thus a gain of 11,374,000 in quantity, but a loss of $838,834 in value. The number of companies reporting as active was 131, an increase of 12 for the year, or 20 more than in 1904. Rockland county was represented by the largest number, 33, and its production amounted to 296,145,000, valued at $1,767,012. Ulster county, with 26 operative companies, produced 252,665,000, valued at $1,465,457; and Orange county made 189,180,000, valued at $1,170,695, reported by 12 companies.

The average number of brick made in each plant in 1906 was 9,471,000, as compared with 10,246,000 in 1905 and 9,180,000 in 1904. The price for the whole region averaged during the y
$5.98 a thousand against $6.54 a thousand for 1905 and $5.
thousand for 1904.

The main feature of the past year's record was the re
range in the market prices received for brick in the N

market. Owing to the great building activity that prevailed during 1905, the whole product of that year was practically disposed of by the close of the brick-making season, and the plants carried little or no stock through the winter. Before the opening of the yards in the spring of 1906 there was a veritable brick famine. Prices reached an unprecedented high level; as much as $10 and even $12 a thousand was paid for the available supply. With the resumption of manufacture they rapidly fell to $8 or $9, and as the season advanced they continued to decline due to a slackening in building operations. As the plants had been brought up

Output of common brick in the Hudson river region in 1905

COUNTY	NUMBER OF PLANTS	OUTPUT	VALUE	AVERAGE PRICE PER M
Albany	8	66 500 000	$439 238	$6 61
Columbia	5	84 750 000	520 500	6 09
Dutchess	17	181 683 000	1 258 937	6 93
Greene	7	55 719 000	377 470	6 77
Orange	12	160 530 000	1 011 006	6 67
Rensselaer	8	25 250 000	133 350	5 28
Rockland	31	302 625 000	2 144 210	7 08
Ulster	23	265 368 000	1 776 035	6 69
Westchester	8	76 893 000	530 465	6 90
Total	119	1 219 318 000	$8 191 211	$6 54

Output of common brick in the Hudson river region in 1906

COUNTY	NUMBER OF PLANTS	OUTPUT	VALUE	AVERAGE PRICE PER M
Albany	11	74 083 000	$461 399	$6 23
Columbia	6	84 500 000	489 750	5 80
Dutchess	19	167 132 000	975 410	5 82
Greene	6	64 690 000	390 748	6 04
Orange	12	189 180 000	1 170 695	6 19
Rensselaer	9	31 776 000	173 906	5 48
Rockland	33	296 145 000	1 767 012	5 97
Ulster	26	252 665 000	1 465 457	5 80
Westchester	9	70 621 000	458 000	6 46
Total	131	1 230 692 000	$7 352 377	$5 98

to their highest efficiency in anticipation of a profitable season, there were also unusually large quantities offered upon the market. In the last months of the season, the prices fell to about $5 a thousand at the yard and held at that level throughout the remainder of the year, with small demand. At the end of the year the stock held by the companies along the river was probably in excess of 300,000,000, or fully 25 per cent of the whole output. A radical curtailment of operations is to be expected for the current season.

Other clay materials

The manufacture of paving brick was carried on during 1906 in Chautauqua, Greene, Onondaga and Steuben counties. There were five companies engaged in the business and the output was 11,472,000, valued at $178,011. In 1905 there were six companies which reported a production of 13,984,000, valued at $180,004.

Fire brick and stove lining were manufactured in Albany, Chautauqua, Erie, Kings, Onondaga, Rensselaer, Richmond, Schenectady, Washington and Westchester counties by a total of 13 companies. The output of fire brick amounted to 12,091,413, valued at $413,147, and the stove lining was valued at $114,512, a combined value of $527,659. In 1905 the value of the two materials was $498,184 reported by 13 companies.

Drain tile and sewer pipe were made in Albany, Cayuga, Chautauqua, Erie, Genesee, Kings, Madison, Monroe, Oneida, Onondaga, Ontario, Saratoga, Seneca, Washington and Wayne counties. The output of drain tile was valued at $166,645, against $146,790 in 1905; and sewer pipe at $95,142, against $444,457. There were 26 companies engaged in this branch of the industry, a gain of two as compared with the previous year.

Terra cotta, fireproofing and building tile were produced in Albany, Allegany, Chautauqua, Erie, Genesee, Kings, Monroe, Onondaga, Ontario, Queens, Rensselaer, Richmond and Steuben counties, by a total of 17 companies, or three less than in 1905. The production of terra cotta was valued at $1,037,387, against $874,717 in 1905; fireproofing at $120,282, against $133,395; and building tile at $217,475, against $251,600.

New manufacturers of clay materials

The following list includes the names of the companies or individuals who have erected plants during the past year, or have taken over old plants, for the manufacture of clay structural materials. The list is supplementary to the one published in the report for 1905.

NAME	LOCATION OF PLANT
Albany co.	
Corwin & McCullough	Coeymans
Powell & Minnock	Coeymans
C. A. Smith	Albany
Edward J. Smith & Co.	Albany
Ziegler & Ziegler	Coeymans
Dutchess co.	
Harlem Valley Brick & Supply Co.	Amenia
John Nicholson	Dutchess Junction
Herkimer co.	
Staley & Co.	Ilion
Orange co.	
George W. Hunt	Chelsea
Rensselaer co.	
Palmer Bros.	Troy
Rensselaer Brick Co.	Rensselaer
G. L. Tobin	Castleton
Richmond co.	
Rossville Brick Co.	Rossville
Rockland co.	
Lynch & O'Brien	Haverstraw
Reilly & Marks	Stony Point
West Haverstraw Brick Co.	West Haverstraw
Schenectady co.	
Cady & Vandenbergh	Schenectady
Electric City Clay Brick Co.	Glenville
Suffolk co.	
The Brown Clay Works	Fort Salonga
Ulster co.	
Lowe Brick Co.	New Paltz
Estate of A. S. Staples	Port Ewen
Ulster Brick Co.	Saugerties
W. M. Burhans, Executor	Saugerties

Pottery

The manufacture of pottery has become an important branch of the clay-working industry of the State. Its development, however, has been due rather to the exceptional facilities afforded by the State for manufacturing and marketing the products than to the existence of natural resources of crude materials that are employed in the potteries. With the exception of the deposits of slip clay in Albany county and a limited supply of stoneware clays in Onondaga county, the raw materials are derived entirely from without the State. The kaolin used comes from New Jersey and from England, the feldspar from Canada, and much of the pottery clay from New Jersey.

In the accompanying table is shown the value of the pottery manufactures during the past three years. The total valuation of the product for 1906, as returned by the individual plants, was $1,795,008. The preceding year's output was valued at $1,620,558 and that of 1904 at $1,438,634. The growth of the industry during the period has been brought about by the increased production of the high grade products — porcelain and semiporcelain tablewares and electric and sanitary supplies. The manufacture of stoneware and earthenware has remained almost stationary. The products listed in the table under " Miscellaneous " include yellow and Rockingham wares, clay tobacco pipes, fire clay crucibles and artistic pottery.

There were 22 potteries that reported as active in 1906, the same number as in the two preceding years. They were distributed among the following counties: Albany, Chautauqua, Erie, Kings, Madison, Monroe, Nassau, Onondaga, Ontario, Schenectady, Suffolk, Washington and Wayne. Onondaga holds first place in point of production, with a total for 1906 valued at $858,270, as compared with $718,985 in 1905 and $673,590 in 1904. Kings county is the second largest producer, contributing an output valued at $306,105, against $308,443 in the preceding year and $279,009 in 1904.

The Rochester City Pottery of Rochester making earthenware and the Van Der Meulen & Wylstra Art Pottery Co., of Dunkirk, making delft reported an output in 1906 for the first time.

Value of production of pottery

WARE	1904	1905	1906
Stoneware	$77 726	$115 890	$84 031
Red earthenware	44 990	30 740	30 234
*a*Porcelain and semiporcelain	740 000	800 000	835 000
Electric and sanitary supplies	490 095	600 325	768 236
Miscellaneous	85 823	73 603	77 507
Total	$1 438 634	$1 620 558	$1 795 008

a Includes china tableware.

Crude clay

In the foregoing tables relating to clay products no account has been taken of the crude clay entering into their manufacture. There are a few producers in the State who do not utilize the crude clay themselves, but ship their output to others for manufacture. Some of the material, like the Albany slip clay for example, is even forwarded to points without the State. In 1906, returns were received from four firms engaged in this industry whose total shipments amounted to 5477 short tons valued at $9125. The corresponding total for 1905 was 6766 tons with a value of $16,616 and for 1904 8959 tons with a value of $17,164.

EMERY

The emery deposits near Peekskill were worked on about the usual scale during the past year. The output reported by the four producers that were active amounted to 1307 short tons valued at $13,870. This compares with a total of 1475 tons valued at $12,452 in 1905 and 1148 tons with a value of $17,220 in 1904. The valuation is based on the crude material as it comes from the quarries where it undergoes only a rough sorting before shipment. The lump emery is sent to outside points for grinding and manufacture into emery wheels, stones, cloth, etc.

The list of producers in 1906 includes the following: Blue Corundum Mining Co., Easton, Pa., Keystone Emery Mills, Frankford, Pa., J. R. Lancaster, Peekskill and the Tanite Co. Stroudsburg, Pa. The Keystone Emery Mills have taken over the properties formerly worked by H. M. Quinn. With the exception of J. R. Lancaster who sells his product to the Hampden Corundum Wheel Co., of Springfield, Mass., the companies mine the emery for their own consumption in connection with manufacturing plants.

FELDSPAR

The quarries of feldspar at Bedford, Westchester co., were operated as in previous years by P. H. Kinkel of that place and yielded their average output. In connection with the working of the quarries a considerable quantity of quartz, or flint as it is commonly termed, was obtained. The feldspar was shipped to Trenton, N. J., where it is employed in the manufacture of porcelain wares. An additional source of supply for the mineral received attention during the past year, the locality being in Washington county, about 3 miles north of Fort Ann. The feldspar is found here in a pegmatite dike. A quarry had been opened some 20 years ago and worked for a time for the quartz which is mixed with the feldspar. Only a small quantity of feldspar was taken out in the past year. The operator of the quarry was Dominic Ashley of Glens Falls. The combined production of feldspar and quartz in New York State amounted in 1906 to 13,660 long tons valued at $44,350. The total for the previous year was 17,000 long tons valued at $48,500.

GARNET

Though there have been no new sources of supply for garnet, other than those described in the previous report, the mining industry has shown unusual progress during the past year. The demand for the mineral among abrasive manufacturers seems to be expanding rapidly at present.

The occurrence of garnet may be said to be quite widespread in the Adirondacks and other regions where the rock formations have a metamorphosed character. It is only seldom found, however, in deposits of sufficient size and richness and at the same time with the proper physical qualities to warrant commercial exploitation. There is little to be feared, apparently, from a possible overproduction, at least from the present mining sections.

The output from the Adirondack region has been made by three companies: the North River Garnet Co., with mines at Thirteenth lake, Warren co; H. H. Barton & Son Co., who operate the deposits on Gore mountain, near North River; and the American Glue Co., with mines on Garnet peak, north of the latter locality. The first named company has been the largest producer. Its new mill which was first started in 1905 was in continuous operation during the past year. The deposits are so situated that they can be worked through the winter. At the other localities where the garnet is obtained by open cutwork and hand sorting, operations can not be carried on to advantage in the winter months.

The newly discovered deposit near Keeseville, Essex co., noted in the report for 1905, has been under development, but made no output except a small quantity for experimental purposes. The recent work has shown the deposit to be of large extent. The garnet occurs in massive form, frequently more or less granulated and admixed with green pyroxene. It has been used experimentally in the manufacture of abrasive wheels, with results reported as very satisfactory. The property is owned by G. W. Smith of Keeseville.

The production reported by the companies for 1906 was the largest on record, amounting to 4729 short tons valued at $159,298. In the preceding year the total was 2700 tons valued at $94,500, and in 1904 it was 3045 tons valued at $104,325. The relatively small output for 1905 was due in part to a temporary curtailing of operations by the North River Garnet Co., incidental to starting their new plant.

GRAPHITE

The production of crystalline graphite in the Adirondack region showed an unexpected falling off during the past year. It amounted to a total of 2,811,582 pounds valued at $96,084, as compared with 3,897,616 pounds valued at $142,948 in 1905 and 3,132,927 pounds valued at $119,509 in 1904. The output for 1905 was probably the largest that has been made in any one year since the establishment of the industry. The average value of the graphite per pound was 3.4 cents in 1906, 3.7 cents in 1905 and 3.8 cents in 1904, showing that there has been a decrease also in the market prices received for the product. The relatively small output in 1906 can not be ascribed to any general conditions that are likely to influence adversely the future progress of the industry, but is doubtless a temporary feature incidental to the limited scope of the operations as carried on at present.

The Adirondack graphite deposits which are being exploited are of the bedded type, the graphite occuring as disseminated flakes in a rock matrix, which may be limestone, quartzite or a silicious schist. The rocks are ancient sediments that have been thoroughly metamorphosed, and it is believed that the graphite has originated from included organic matter that was distilled by the heat to which they have been subjected, with a resultant loss of the volatile constituents. The rocks which have a thoroughly crystalline character, occur in force on the borders of the Adirondacks, but are less abundant in the interior. Their content in graphite is variable. As an extreme it may reach 8 or 10 per cent, which is found only in the deposits owned by the American Graphite Co., near Hague. The average for the other deposits that have been worked probably does not exceed 3 per cent.

The companies who have reported a production for 1906 are: American Graphite Co., with mines at Graphite, near Hague, Warren co.; Crown Point Graphite Co., operating near Penfield pond, Essex co.; Pettinos Bros., with mines at Rock pond, Essex co.; Adirondack Mining & Milling Co., and Champlain Graphite Co., with mines at South Bay, near Whitehall, Washington co. The plant of the Ticonderoga Graphite Co., at Rock pond, was leased to Pettinos Bros., of Bethlehem, Pa., who operated it for only a brief period. The graphite rock was found to be cut out by a fault. The Adirondack Mining & Milling Co. was active only for a period of three weeks, and will not resume operations during the present year.

The Glens Falls Graphite Co. has been incorporated for the purpose of working a graphite deposit situated near Conklingville, 8 miles west of Hadley, Saratoga co. The deposit is described as a quartzose schist with a thickness of 50 feet where opened. The erection of a mill is in progress, which it is expected will be completed early in the year.

The Empire Graphite Co. is engaged in developing a property near Greenfield, Saratoga co.

Some prospecting has been done in the vicinity of Graphite with a view to locating a possible extension of the bed worked by the American Graphite Co. Drill tests have indicated that the quartzite underlies a considerable area to the west of that company's property. In three holes which were put down the graphitic bed was found to be from 19 to 22 feet thick and was encountered at 50 to 75 feet depth.

GYPSUM

The industries connected with the production of gypsum and its manufacture into commercial products have progressed rapidly during recent years. The advance has been due to the utilization of the material for wall plaster and plaster of paris, a branch of the industry that has been developed in New York State practically since 1900. Previous to that year the output of crude gypsum averaged less than 50,000 tons annually and was used almost wholly for agricultural purposes. Though the deposits of the State do not yield, as a rule, a material of high degree of purity, it has been found to be well adapted for making the usual grades of calcined plasters.

The quarries of gypsum are situated along a belt extending west from Madison county through Onondaga, Cayuga, Seneca, Ontario, Monroe, Genesee and Erie counties. The gypsum is found in one or more beds associated with the Camillus shale of the Salina group. The beds range up to 30 feet or more in thickness. They are worked only along the outcrop, generally by open pit methods, though underground mining is practised to some extent in the western section. The manufacture of wall plaster is carried on principally in the vicinity of Syracuse, Onondaga co., at Wheatland and Garbutt, Monroe co., and at Oakfield, Genesee co.

The output of gypsum in crude form during 1906 amounted to 262,486 short tons, reported by 16 producers. In 1905 the output was 191,860 short tons and in 1904 it amounted to 151,455 tons. The greater part of the output was converted into wall plaster and plaster of paris, the combined product of these materials amounting to 163,451 short tons valued at $595,285 against 130,268 tons valued at $478,084 in the preceding year. The totals include only the quantities made from gypsum mined or quarried in the State; in addition there is a production of wall plaster and plaster of paris from imported material for which no returns are received. The quantity of gypsum that was ground and sold for land plaster amounted in 1906 to 20,656 short tons valued at $46,094, against 19,815 tons valued at $39,014 in the preceding year. A further portion amounting to 34,626 tons valued at $58,076 in 1906 and to 27,980 tons valued at $34,095 in the preceding year was sold in the crude state.

Production of gypsum

	1905		1906	
	Short tons	Value	Short tons	Value
Total output	191 860	....	262 486	....
Sold crude	27 080	$34 095	34 626	$58 076
Ground for land plaster	19 815	39 014	20 656	46 094
Wall plaster etc. made	130 268	478 084	163 451	595 285
Total value	....	$551 193	....	$699 455

Unusual attention has been given during the past year to the exploration of the gypsum deposits of the State, with results that promise to contribute toward the further expansion of the industry in the immediate future. In Onondaga county a new company has been engaged in the development of a deposit near Jamesville. A vertical shaft was put down to a depth of 100 feet and encountered about 40 feet of gypsum at the bottom. The Lehigh Portland Cement Co. and E. B. Alvord & Co. were active in exploring for deposits in the same district. The American Gypsum Co. has developed a property near Alabama, Genesee co., where the Akron Gypsum Co. has also opened a deposit. The former company intends to erect a calcining plant. The Monarch Plaster Co. began production for the first time in 1906 from its mine situated at Wheatland, Monroe co. Exploratory operations have been under way also near Leroy and Oakfield, Genesee co.

IRON ORE

The revival of interest in iron ore mining noted in the preceding issue of this report has continued to exert a very favorable influence upon the industry of the State. A larger number of mines have been active during the past year than at any time since the memorable depression immediately following 1890 which brought about the abandonment of most of the local enterprises. The production, also, has shown a satisfactory gain, and with the increment that will be contributed by the new undertakings when they are under full headway, it should undergo still further expansion.

Altogether there were 11 companies engaged in mining operations. This number includes only those reporting a commercial production of ore. There were several other companies that had properties under exploration or development, and some of them will begin shipment during the current year.

The accompanying table gives the annual production of iron ore for the period of 1890–1906 inclusive. The statistics covering the years previous to 1904 are taken from the volumes of the *Mineral Resources* published by the United States Geological Survey, while those for 1904 and subsequent years have been collected at this office.

Production of iron ore in New York State

YEAR	MAGNETITE	HEMATITE	LIMONITE	CARBONATE	TOTAL	Total value	Value per ton
	Long tons	Long tons	Long tons	Long tons	Long tons		
1890	945 071	196 035	30 968	81 319	1 253 393	....	.....
1891	782 729	153 723	53 152	27 612	1 017 216	....	.....
1892	648 564	124 800	53 694	64 041	891 099	$2 379 267	$2 67
1893	440 693	15 890	35 592	41 947	534 122	1 222 934	2 29
1894	....	....	....	....	242 759	....	.....
1895	260 139	6 769	26 462	13 886	307 256	598 313	1 95
1896	346 015	10 789	12 288	16 385	385 477	780 932	2 03
1897	296 722	7 664	20 059	11 280	335 725	642 838	1 91
1898	155 551	6 400	14 000	4 000	179 951	350 999	1 95
1899	344 159	45 503	31 975	22 153	443 790	1 241 985	2 80
1900	345 714	44 467	44 891	6 413	441 485	1 103 817	2 50
1901	329 467	66 389	23 362	1 000	420 218	1 006 231	2 39
1902	451 570	91 075	12 676	Nil	555 321	1 362 987	2 45
1903	451 481	83 820	5 159	Nil	540 460	1 209 899	2 24
1904	559 575	54 128	5 000	Nil	619 103	1 328 894	2 15
1905	739 736	79 313	8 000	Nil	827 049	2 576 123	3 11
1906	717 365	187 002	1 000	Nil	905 367	3 393 609	3 75

The total shipments reported by the mines in 1906 amounted to 905,367 long tons valued at $3,393,609. Compared with the previous year this was an increase of 78,318 tons or about 9 per cent. The production was more than double that reported for 1901 and was the largest for any year since 1891.

Classified as to variety the shipments consisted of 717,365 tons of magnetite, 187,002 tons of hematite and 1000 tons of limonite. Of the magnetite 479,644 tons were marketed in the form of concentrates with an approximate content of 65 per cent iron. The 237,721 tons of lump magnetite included in the total are estimated to average 60 per cent. The hematite and limonite range from 40 to 60 per cent, with an average probably of 45 per cent.

The magnetite concentrates were made from 729,091 tons of crude ore. Using that figure for a basis of calculation, the total quantity of ore hoisted from New York mines in 1906 was 1,154,814 long tons. In 1905 the quantity was 1,109,385 long tons.

The magnetite was derived mainly from the Adirondack region. The producers included Witherbee, Sherman & Co. and the Port Henry Iron Ore Co. at Mineville; the Arnold Mining Co. at Arnold; and the Chateaugay Ore & Iron Co. at Lyon Mountain. The Salisbury Steel & Iron Co. made a small output in connection with the development of their mine at Salisbury. In southeastern New York the Hudson Iron Co., which took over the Forest of Dean mine in 1905, began shipments. It has been the only producer in that section.

Of the total quantity of hematite reported the mines in the Clinton formation contributed a little more than half. The Franklin Iron Manufacturing Co. and C. A. Borst at Clinton and the Furnaceville Iron Co. at Ontario operated the mines. The remainder of the hematite came from St Lawrence and Jefferson counties where the Rossie Iron Ore Co. and the Old Sterling Iron Co. were active.

The single producer of limonite was the Amenia Co. at Amenia, Dutchess co.

The Fair Haven Iron Ore Co. was engaged in developing its properties near Sterling Station, Cayuga co., but produced only small quantities for trial purposes. It will begin commercial shipments this year.

In the Adirondack region, the exploration of the titaniferous magnetites near Lake Sanford, Essex co., has attracted much attention. It has been known for many years that the ore bodies are of enormous extent, and the recent tests have confirmed and added to the previous estimates. The successful issue of the enterprise must depend of course upon the metallurgical factor, which has hitherto deterred iron manufacturers from attempting to utilize the ore in blast furnaces. It is the purpose of the present company to carry out a thorough investigation with a view to finding a commercial outlet for the ore. Considerable quantities of the ore have been mined and shipped for experiment to furnaces and to the magnetite concentrators at Mineville.

The Cheever mine near Port Henry, Essex co., is to be reopened. The mine which has been closed down for about 15 years has been equipped with pumps for unwatering the underground workings. It is planned to erect a concentrator during the present season.

The Benson mines in St Lawrence county have been taken over by new parties who will begin mining operations during the current year. It is intended at the start to use the old mill, after the necessary improvements have been made, but a new one will be erected if warranted by the developments.

The Hammondville district in Essex county has been under exploration by the Oliver Iron Mining Co. A magnetic survey was carried out, and the ground further tested by the diamond drill. The results have shown the existence of ore bodies hitherto unworked, but the reserves thus far found have not been sufficient to warrant a renewal of mining operations.

Notes on recent mining developments

Mineville. The production from this district was curtailed to some extent by a temporary suspension of operations on the part of the Port Henry Iron Ore Co. A slide of rock and earth last spring partly filled the large open pit in mine "21" and prevented access underground through the inclined shaft at the bottom. The shaft was retimbered and restored, but no ore was taken out for several months. Work in the pit has been discontinued. The company has started a new shaft in order to forestall any further trouble from similar sources. It is located 500 feet south of the present one and east of the Bonanza shaft of Witherbee, Sherman & Co. which is on the same ore body.

Mining was continued by Witherbee, Sherman & Co. in the five shafts worked during the preceding year, comprising the Joker an
Bonanza on the Old Bed, A and B shafts on the Harmony ore b
and Cook shaft. The two mills for treating the ore have
been in commission. Exploration work has been prosecuted
company with little interruption, and the available ore su
well ahead of the production. The results obtained by

drilling on the Old Bed have been particularly favorable. The extension of the deposit to the south has been practically established for a distance of several hundred feet beyond the present limits of the workings. With the enormous development shown by the ore body in cross-section, every foot added to its longitudinal extent means an important addition to the ore reserves.

The construction of a new power plant was begun by Witherbee, Sherman & Co. during 1906. The building is situated on the lake side at Port Henry, and is constructed of concrete made of cement and mill tailings. It will supply 800 kw. A 6 mile transmission line will connect the plant with the mines. This increment to the power supply will enable the company to enlarge considerably its mining operations.

Lyon Mountain. The mines were continuously active during 1906 and their output has been larger than for several years past. The increase has been made possible by the erection of a new mill which has doubled the former capacity for concentrating the ore and which was placed in operation for the first time during the summer. Other additions to the plant have been in course of construction, including the installation of a central power station, air compressors, new trackage, and houses for the miners.

The new mill was designed for the treatment of 1200 tons crude ore a day or 50 tons an hour. The results thus far obtained show that under normal conditions it is capable of a considerable larger output. It also effects an important saving in the item of labor. The concentrates turned out run about 63 per cent iron. In the old mill about 6 per cent of iron was lost in the tailings, while now the latter carry only 4 per cent as an average.[1]

The central power station when completed will have a capacity of 3000 h.p. It is to replace the small power plants that are distributed among the different shafts and the old separator. The first third of the station developing 1000 h.p. has been completed and put in operation. It supplies power to the new mill through a 500 kw. generator directly connected to a Curtis turbine. In the same room is installed a cross-compound two stage air compressor for furnishing air to the drills.

As described in the issue of the bulletin for 1905, the mines at Lyon Mountain are very extensive. The ore bodies form a practically continuous belt from 5 to 6 miles long. Mining at present is confined to the central part of the belt for a distance of about 2000 feet along the outcrop. There are three parallel veins in this part. The principal underground workings are the Hall slope and the adjacent nos. 3, 4 and 5 slopes situated on the front vein. The greatest depth reached is about 1400 feet on the incline, or 800 feet vertically. In the bottom of the Hall slope the horizontal drifts are about 200 feet wide. On the back vein the Burden and Cannon open pits, southeast of the slopes named, have continued to furnish a large quantity of ore.

---

[1] Consult article by D. H. Newland and N. V. Hansell, in Eng. & Min. Jour., Nov. 10 and 17, 1906.

The furnace of the Northern Iron Co., located at Standish near Lyon Mountain, is run on concentrates from these mines, the product being low phosphorus pig iron that finds a special market. Shipments of concentrates are also made to Pennsylvania furnaces.

Arnold hill. The Arnold Mining Co. closed down its mines and mill during the summer. Though the ore resources can not be regarded as exhausted, it was found difficult to maintain the production at a rate that would supply the mill for continuous running. The ore body that has been mined is irregular and showed evidences of pinching out in depth. There are several other deposits on Arnold hill, as well as on the adjacent hill to the east, from which an adequate output for the mill might be derived if properly developed.

Cheever mine. It is expected to begin ore shipments once more from this mine during the present year. The property has been inactive since 1893. According to the plans drawn up by Mr O. S. Presbrey, the owner, the Weldon shaft on the south end of the ore outcrop will be first reopened. There is known to be a quantity of ore still unworked in this section. A mill will be erected near the shaft for concentrating the leaner magnetite that has been stocked on the surface from previous operations and of which much remains in the mine. The ore previously shipped consisted entirely of lump material running 60 per cent or over in iron.

The Cheever mine is situated about 2 miles north of Port Henry close to the shore of Lake Champlain. It is based on a series of deposits that can be traced along the strike for nearly a mile. For a few hundred feet from the outcrop the ore dips sharply to the west or southwest, but then continues nearly horizontal, slightly rising in places, toward the ridge of gabbro which cuts it off on the west. It is frequently faulted and intersected by dikes. The old workings are said to cover an area of 40 acres. The deposits range up to feet thick.

The ore in appearance and composition is much like that from the Mineville deposits. It is, however, lower in phosphorus than the Old Bed product, with an iron content of from 63 to 65 per cent. The shipments are reported by Smock to have amounted in all to 800,000 tons.

Lake Sanford. The property formerly owned by the McIntyre Iron Co., comprising over 100 square miles in western Essex county within which the Lake Sanford titaniferous magnetite deposits are located, has been taken over by parties for the purpose of exploration and development. The new company has been organized by Mr W. T. Foote, who is actively identified with its management. It is to be known as the Tahawus Iron Ore Co. Exploratory work has been under way throughout the past year.

The Lake Sanford ore bodies are the largest of their kind in the Adirondacks and undoubtedly rank among the largest deposits of iron ore in the entire country. They were first made known to the public through the descriptions of Professor Emmons in his reports on the Survey of the Second Geological District. They have since been investigated by Prof. J. F. Kemp,[1] who has given a very full account of their geology as well as of their mineralogical and chemical characters.

The diamond drill tests made during the past year have demonstrated that the ore bodies, which have hitherto been known only from outcrop, extend to considerable depths and that there are enormous resources of ore available for easy extraction. On the Sanford deposit the drills have shown as much as 360 feet of ore, and they have nowhere passed into the foot wall. This ore body was prospected by Professor Emmons who, as a result of his observations which have been recorded with much detail, estimated that it contained over 6,000,000 tons of ore within a distance of 2 feet below the adjoining surface. The bounds of the deposit as known to him have been greatly extended by subsequent investigations.

The ore from this locality is a coarse titaniferous magnetite. It is nearly free from admixed minerals of the wall rock, except on the borders where more or less feldspar and pyroxene are present. The deposit is well situated for working, as it outcrops along the sides and crest of a hill which rises about 300 feet above the shore of Lake Sanford. Quarry methods can be used here to advantage.

The recent exploration has disclosed the existence of an area of ore-bearing ground north and west of Calamity brook, near the outlet of Lake Henderson. The tract lies without the limits of the deposits that have been previously described. Though much of the ore is mixed with rock there are large bodies of practically solid magnetite of a quality not inferior to the Sanford ore. The following is a record of one of the drill holes.

---

[1] Titaniferous Iron Ores of the Adirondacks. U. S. Geol. Sur. 19th An. Rep't, pt III.

	Feet	Inches
Lean ore, consisting of disseminated magnetite with feldspar and pyroxene	19	3
Rich ore	30	6
Rock and lean ore mixed	15	..
Rich ore	33	6
Rock carrying some ore	11	1
Lean ore	12	..
Rock and lean ore	8	..
Rich ore alternating with rock	10	7
Rock	5	..
	144	11

The Cheney ore bed west of Lake Sanford and the several deposits between Lakes Sanford and Henderson are known to be extensive.

An interesting feature that has been brought out by recent experimentation with the ores is the possibility of reducing the titanium by mill treatment. It has been established that in some cases at least this element is not uniformly distributed in chemical combination with the iron, as has been advanced by some writers. By crushing the ore to fine size and passing over magnets, a process like that used in the concentration of nontitaniferous magnetites, it is found that a separation can be made into a strongly magnetic portion and a residuum that is very weakly magnetic. The magnetic material shows on analysis a smaller content of titanium than the average of the ore used in the experiment, the content decreasing with the fineness to which the ore has been crushed. The weakly magnetic portion, which passes into the tailings, contains on the other hand an increased proportion of this element. The experiments seem to prove beyond all doubt that in such cases the ore consists of a mechanical mixture of two minerals, one of which is magnetite, with only a small amount of titanium, and the other a titanium-bearing iron oxid that is probably ilmenite. With the Sanford ore, it has been found that the titanium can be brought down to a limit where the utilization of the concentrates in the blast furnace appears to be practicable. It may be pointed out that practically all of the so called nontitaniferous magnetites of the Adirondacks, as probably elsewhere, carry titanium, though the amount, of course, is small, usually less than 1 per cent.

Besides the possibility of concentration, it is not unlikely that a portion of the titaniferous ore can be used in crude state. Analyses show that the titanium is extremely variable. Some ores from the district contain only about 5 or 6 per cent, so that by mixing with ores free from titanium the percentage could be reduced to a fraction of that amount. The open-hearth process of steel making furnishes another possible outlet.

The Lake Sanford deposits are situated in the interior of the Adirondacks, on the slopes of the rugged mountain group centering around Mt Marcy. Their elevation of outcrop averages about 2000 feet above sea level. The nearest railroad point is North Creek, about 30 miles distant. The problem of transportation is thus a critical one; the construction of a branch railroad is now under consideration.

Forest of Dean. The Hudson Iron Co. began active mining at this locality during 1906. The company took over the mine in October 1905, but as the work of unwatering and reequipping extended over several months, no shipments were made until the following summer.

The Forest of Dean mine is situated 5 miles west of Fort Montgomery, Orange co. It has the longest record as a producer, probably, of any mine in the country that is now under operation. According to Beck it was worked as early as 1756. In the period from 1865 to 1894, when it was under the ownership of the Forest of Dean Iron Ore Co., the production amounted to over 500,000 tons.

The ore body consists of an immense shoot that is apparently folded upon itself into a synclinal, the two wings of which extend to the surface. The wall rock and ore dip steeply southeast, while the latter pitches to the northeast. The horse of gneiss separating the two wings of the fold wedges out with depth. Access to the underground workings is had through a slope driven on the foot wall. The slope has been carried to a distance of 1700 feet from the surface and a vertical depth of 700 feet.

The ore is a rich magnetite of non-Bessemer character. An analysis quoted from Smock's report shows the following percentages:

Iron oxid (Fe_2O_3)	83.56
Silica (SiO_2)	5.00
Phosphoric anhydrid (P_2O_5)	2.30

Alumina (Al_2O_3)	tr
Manganous oxid (MnO)	.63
Lime (CaO)	5.51
Magnesia (MgO)	1.19
Carbon dioxid (CO_2)	1.05
Water (H_2O)	.20
	99.44

The company owns a furnace at Secaucus, N. J., to which the ore is shipped. In order to reach the Hudson river, a tramroad 4 miles long has been built. At the terminal of the road the ore is loaded into the buckets of an aerial rope conveyor, 6300 feet long, which carries it to the dock at Fort Montgomery where there is a 1000-ton storage bin. The power for driving the air compressor and pump at the mine is taken from the adjacent Popolopen creek.

Caledonia mine. This mine situated in the hematite district of St Lawrence and Jefferson counties has been operated in recent years by the Rossie Iron Ore Co. It has furnished altogether probably 500,000 tons of ore. The record for the past year has been a very creditable one, the output having been more than double that for 1905, while large resources have been opened for future exploitation. The company has recently enlarged and improved its surface plant which will enable it to increase the production still further.

The ore is a fairly rich soft hematite, running from 50 to over 60 per cent in iron. Its quality seems to improve somewhat with the progress of mining in depth.

It carries a relatively high proportion of lime which with its excellent physical character makes it very adaptable to furnace treatment. A rough sorting is required to remove admixed rock, and about one fourth of the material hoisted is thus rejected at the surface. An analysis[1] of shipping ore shows the following chemical constituents:

Iron (Fe)	52.71
Silica (SiO_2)	10.12
Alumina (Al_2O_3)	7.04
Manganous oxid (MnO)	1.69
Lime (CaO)	7.04
Magnesia (MgO)	0.38
Carbon dioxid (CO_2)	5.41
Sulfur (S)	.03

---

[1] See article by Robert B. Brinsmade, Eng. & Min. Jour. Sept. 15, 1906.

From an average of several determinations, the phosphorus may be placed at about .5 per cent.

The ore occurrence furnishes an interesting example of the replacement type of deposits. The associated rocks are crystalline limestone and schists of Precambric (Grenville) age and Potsdam sandstone. The Precambrics have a northeasterly strike and a variable dip generally to the southeast. They are overlain by the sandstone with a marked erosional unconformity at the base. The dip and strike of the sandstone are subject to rapid changes from place to place, though it usually lies more nearly horizontal than the other formations.

The limestone and schist form an interbedded series that is seemingly conformable. Alternating belts of the two rocks occur across the strike, the repetition being due probably to successive folds with northeast-southwest axes. The schist is a quartzose graphitic variety, finely laminated as a rule. It doubtless represents an original silicious shale that contained considerable carbonaceous matter. Secondary alteration, apparently connected with the process of ore formation, has resulted in the development of chlorite from the silicates, forming a chlorite schist. This is locally called serpentine, but there is very little true serpentine present, so far as observed. The chlorite schist is always closely associated with the ore.

In many places the sandstone capping is notably altered at the base. It is decomposed to a soft iron-stained material, at times carrying a fairly large percentage of hematite and grading into the ore bodies below.

At the Caledonia mine the deposits follow the contact between a belt of limestone which constitutes the foot wall and an overlying belt of schist. They have a pronounced irregular often sinuous form, with bulges and pinches along the strike and dip. They frequently branch and run off for some distance into the hanging and foot walls. The limestone along the contact has been dissolved out to form deep cavities and these may be filled with ore. Horses of both limestone and schist are not infrequently encountered in the midst of the deposits. The workings do not appear to have penetrated anywhere the Potsdam, though it occurs on the hanging side within probably 100 feet of the edge of the limestone. Where seen on the surface above the workings it has a high dip to the east. The tilting has been due probably to settling of the surface owing to removal of the limestone by solution.

There are abundant evidences that the ore deposits have originated by a process of replacement. The cores of schist show gradation from the central unaltered nuclei outward into the rich hematite. Specimens of the ore may be found that still show the banding and cleavage characteristic of the schist. The presence of graphite, which would naturally be the most resistant of the minerals to solvent action, furnishes a clue to the origin of the ore even when all the other primary constituents have been removed. The relatively high percentages of silica and lime in the ore are likewise suggestive in that connection.

As to the source from which the ore has been derived, Prof. C. H. Smyth[1] jr has given an explanation that accords best with the geological phenomena surrounding the occurrence. Though based principally on observations made at the Old Sterling mine, the theory is equally applicable to the Caledonia ore body and in fact to all of the deposits in the district. Briefly stated, it ascribes the formation of the ore to the circulation of underground waters which have dissolved the iron-bearing minerals from the adjacent rocks and deposited their burden in the form of oxid and carbonate when they came in contact with the limestone. The source of the iron is to be traced to the presence of pyrite and magnetite in the schist. There are bands of schist impregnated with pyrite in the vicinity of the Caledonia mine, as well as at the Dickson and Old Sterling mines. These pyritic bands are developed on a large scale throughout the Grenville schists of St Lawrence county and have for a number of years been the object of mining. By oxidation, the iron would be brought into solution as ferrous and ferric sulfates. Free sulfuric acid would also result and would react upon the veins and disseminations of magnetite in the schist. On coming in contact with the limestone, the solutions would be decomposed, the iron being precipitated as carbonate or limonite, while at the same time the lime carbonate would pass into solution. By subsequent alteration the carbonate and limonite have been changed to hematite. Residual masses of unaltered carbonate are occasionally found in the Caledonia mine. The iron has been precipitated in part in the body of the schist, without the agency of limestone.

Dickson mine. The Old Sterling Iron Co. has recently reopened this property, which has been inoperative for several years. The mine is situated on the southwestern end of the belt in which the Caledonia and Old Sterling deposits are located, about a mile from the latter. It was first worked in 1858.

---

[1] N. Y. State Mus. 47th An. Rep't, 1894. p. 692.

The ore is an earthy hematite, occurring within graphitic schist. There is no limestone exposed in the workings and this rock does not appear to be present in the immediate vicinity. The deposits occupy zones of replacement following the bedding planes of the schist. The dip is to the northwest in an opposite direction to that at the Caledonia mine. The workings have reached a depth of 160 feet on the dip, and range from 10 to 40 feet wide.

Ore has been mined in the past from several pits between the Old Sterling and Dickson mines. There are good opportunities for exploration in the vicinity, as well as in the interval between the Old Sterling and the Caledonia mines. All of the deposits practically that are known have been located by surface outcrops. Their aggregate extent is small compared with the body of the schist, and it is not at all improbable that ore bodies may be found beneath the drift-covered areas. Tests with the dip needle show that the ore bodies have no appreciable magnetic properties, so that exploration would have to be carried on by costeaning or drilling. The thickness of the drift, judging from sections exposed in the district, is nowhere very great, probably less than 50 feet in most places.

The Clinton hematite

BY C. A. HARTNAGEL

The Clinton ores occur as beds in the Clinton formation and extend for a distance of about 120 miles, from Herkimer county as far west as Monroe county. In the eastern section there are present two and some times three beds of ore. The lower oolitic bed is about 8 inches thick and is not at present worked, though in character it is very similar to the oolitic bed occurring 2 feet higher, which is the only one of the three beds now exploited. The lower politic bed is quite local in distribution and is definitely known only on the property of the Franklin Iron Manufacturing Co. The upper bed, locally known as " red flux," is found 24 feet higher. This bed is 5 feet thick and is strictly a fossil ore, consisting largely of bryozoan fragments and lacking oolites which are so characteristic of the lower beds. The analysis of the upper bed gives about 30% iron, which is too low to be profitably employed at present.

In the western section only one bed of ore is found. It here combines the character of the " red flux " and oolitic beds of the eastern section, in that it is made up partly of fossil fragments and partly of oolites. Its stratigraphic position in relation to the beds of the eastern section is not definitely known though it appears to be most closely related to the lower or oolitic beds.

The dip of the Clinton formation varies from 50 to 100 feet per mile and throughout its extent from Herkimer county to Monroe county contains one or more beds of ore. If only a single bed with an average thickness of 20 inches is used as a basis for calculation, the quantity of ore available in each mile of outcrop and an equal distance on the dip amounts in round figures to 5,000,000 long tons.

Furnaceville Iron Co. This company is engaged in mining ore near Ontario Center, Wayne co. The open cut method for mining the ore is here used to good advantage. The overlying soil and rock, 18 to 20 feet thick, are first loosened by blasting and then removed with steam shovels and revolving derricks. To loosen the soil and rock, holes extending downward through the capping and 3 inches into the ore are made with churn drills. The holes are 16 feet apart, the first row being drilled 6 feet from the edge of the trench. The loosened material is removed by steam shovels which drop the material into the buckets of the derricks which convey it to the spoil banks, opposite the long face of the trench and just beyond the edge of the ore which is being cleared of its overburden. Two sets of steam shovels and derricks, working in parallel and along the strike of the bed clear the ore for a width of 60 feet. A layer of limestone, 15 to 18 inches thick, remains on the ore which is not readily removed by the steam shovels. This is blasted away or removed by hand. The ore which is 22 inches thick is loosened by blasting. Steam drills are used and the holes are about 3 feet apart and 3 feet back from the edge of the ore. The drill holes extend about 3 inches into the underlying argillaceous limestone. A small amount of the latter comes off with the ore but it is readily removed. The ore is broken with hammers into convenient size for handling. The ore is then loaded into buckets holding about 2½ tons. A derrick carries the buckets directly to the cars which stand on a branch track of the Rome, Watertown & Ogdensburg Railr
The track is located on the edge of the trench on the side oppo
the spoil bank, and is moved back whenever a new working face
established along the strike. About 16 buckets of ore are
for a car of 80,000 pounds. The ore is shipped to Emporium,

Wolcott. The Clinton ore was formerly mined near Wolc

24 miles east of Ontario. A furnace was in operation there as early as 1824. It is no longer in operation, the last blast having been made in 1869. The ore for the furnace was obtained in township 41, near Black creek, about 4 miles east from the furnace. The overburden is said to consist of 20 feet of soil and rock, the ore being 30 inches thick. The section is no longer accessible for measurement. A small amount of ore was also obtained just below the furnace along Wolcott creek. At present the ore shows a thickness of 14 inches, but as it lies immediately beneath surface soil, it undoubtedly represents but a part of the thickness of the original ore bed.

Fair Haven Iron Co. Ten miles northeast from Wolcott, the Fair Haven Iron Co. has recently begun to take out ore by the open cut method. The holdings of the company consist of 280 acres located at Sterling Station, Cayuga co. The opening for the ore is 400 yards southwest of the station and adjacent to the railroad tracks. The operations are conducted on the opposite side of the railroad from the old workings of the Furnaceville Iron Co. A siding from the railroad leads directly to the workings. The equipment of the company consists of one 60-ton Marion steam shovel, one 15-ton locomotive crane, two derricks, one 30-h.p. boiler, etc.

The company is at present engaged in excavating a trench along the strike of the ore. No large amount of ore has been taken out, but the company will begin shipping during the current year.

Clinton. All the operations now carried on at Clinton for the production of ore are by drifting. The open-cut method was abandoned principally because of the increasing thickness of the overburden.

The mining operations at Clinton are at present carried on by the Franklin Iron Manufacturing Co. and Mr C. A. Borst. The former company operates what were formerly known as the Franklin and Clinton mines. The operations of Mr Borst are carried on a short distance farther north at the two beds known as the Elliott and the Butler.

At both of the mines at Clinton the long wall method of working is used. Briefly this plan consists of a main gangway with branches so arranged that a space of 50 feet can be worked on each side of them. In mining, the working face is kept a short distance ahead of the gangway. When a working face is established the ore is obtained by drilling diagonally from the top of the bed. Upon blasting, the front and lower portion of the ore is thrown out. The ore is trimmed in the mine and loaded into the mine cars. The remaining ore and enough of the overlying shale is then removed by drilling horizontally and blasting, so as to give sufficient hight for the miners to work.

The ore varies from 30 to 36 inches in these mines so that about 18 to 24 inches of shale is removed. The waste from the ore and all the shale removed goes into the gob. The roof is further secured by timbering. The posts are placed parallel to the working face and from 5 to 10 feet apart depending upon the nature of the roof.

The ore is hauled from the mine workings on cars. In the Franklin Iron Manufacturing Co.'s mines the cars are drawn by mules. In the Borst mine, steel cars with roller bearings are used; the grade in the mine is so slight that they can be operated by hand. In this mine steel rails connected by fish plates are used. The track rests directly on the rock so that in reality it serves as a portable railway. In the Franklin mines ventilation is made more perfect by means of a central air shaft.

The product of the Borst mines goes principally to paint manufacturers. The ore from the Franklin mines is smelted at the company's furnace at Franklin Springs about 2 miles south from the mines.

MILLSTONES

Millstones are obtained in Ulster county. The industry is a small one, but it has been established for more than a century and still furnishes most of the millstones made in this country. The product is known as Esopus stone, Esopus being the early name for Kingston, once the principal point of shipment.

The millstones are quarried from the Shawangunk grit, a light gray quartz conglomerate found along the Shawangunk mountain from near High Falls southwest toward the Pennsylvania border. The Cacalico stone obtained in Lancaster county, Pa., and the Brush mountain stone, found in Montgomery county, Va., are of similar character. In Ulster county the grit rests upon the eroded surface of gray Hudson River shales and is overlain by red shale. It has generally been correlated with the Oneida conglomerate of central New York, though recent investigations have shown that it belongs higher up in the series, namely in the Salina. Its thickness ranges from 50 to 200 feet.

The grit is composed of quartz pebbles of milky color inclosed in a silicious matrix. The pebbles are more or less rounded and vary from a fraction of an inch up to 2 inches in diameter. The texture is an important factor in determining the value and particular use of the finished millstones.

The size of the stones marketed ranges from 15 to 90 inches. The greater demand is for the smaller and medium sizes, with diameters of 24, 30, 36, 42 and 48 inches. A pair of 30-inch millstones commonly sells for $15, while $50 may be paid for a single stone 60 inches in diameter. The largest sizes bring from $50 to $100. Besides the common type of millstones, disks are furnished which are employed in a roll type of crusher known as a chaser. The pavement of such crushers is also supplied by the quarrymen, in the form of blocks. Quartz, feldspar and barytes are commonly ground in chasers.

Most of the Ulster county quarries are situated along the northern edge of the Shawangunk mountain. Kyserike, St Josen, Granite and Kerhonkson are the principal centers of the industry while the distributing points include New Paltz and Kingston in addition to those named. The industry is carried on intermittently, many of the producers engaging in other occupations during a part of the year.

The market for millstones has been curtailed of late years by the introduction of rolls, ball mills and other improved forms of grinding machinery. The roller mill process has displaced the old type of cereal mills, particularly in grinding wheat. The small corn mills distributed throughout the southern states, however, still use millstones and furnish one of the important markets for the New York quarries. A part of the product is sold also to cement and talc manufacturers.

The production of millstones in 1906 amounted to a value of $22,442, or nearly the same as in the previous year when a valuation of $22,944 was reported. The production in 1904 was valued at $21,476.

MINERAL PAINT

The term mineral paint is here used to designate the natural mineral colors obtained by grinding an ore or rock. The materials suitable for this purpose that are found in New York State include iron ore, shale, slate and ocher.

For metallic paint and mortar colors some form of iron ore, generally hematite or limonite, is commonly employed, but only a few localities are known where the ore possesses the requisite qualities of color and durability. The fossil hematite from the Clinton formation is perhaps most widely used in this country. The mines owned by C. A. Borst at Clinton, Oneida co., and those of the Furnaceville Iron Co. at Ontario, Wayne co., supply much of the crude material.

The red hematite mined by the Rossie Iron Ore Co. at Rossie, St Lawrence co., also yields a good metallic paint.

Mineral paint made from shale and slate is quite extensively used for wooden structures. When there is a considerable percentage of iron oxids present, the shale and slate may be sold for metallic paint. Their value depends largely upon the depth and durability of their color; but the degree of natural fineness and the amount of oil required in mixing must also be considered in determining their utility. At Randolph, Cattaraugus co., beds of green, brown and bluish shale occur in the Chemung formation. They are worked by the Elko Paint Co. In years past red shale has been obtained in Herkimer county from the Vernon beds at the base of the Salina. A similar material occurring in the Catskill series has been worked at Roxbury, Delaware co. The red slate of Washington county, which belongs in the Cambric, is also ground for paint. The Algonquin Red Slate Co. of Worcester, Mass., and A. J. Hurd of Eagle Bridge produce this material.

A product known as mineral black is made by grinding slate found in the Hudson River series.

The ferruginous clay called ocher occurs quite commonly in the State, but no deposits are exploited at present. A bed occurring on Crane mountain, Washington co., once supplied a considerable quantity.

Sienna, a variety of ocher, occurs near Whitehall. The deposit is a thin stratum in glacial drift and has been worked on a small scale.

In addition to the producers above mentioned, the Clinton Metallic Paint Co. of Clinton, and the William Connors Paint Manufacturing Co. of Troy, are engaged in the manufacture of mineral paints from New York materials.

The production of mineral paints in 1906 was as follows: metallic paint and mortar color 2714 short tons valued at $29,140; slate pigment 2045 short tons valued at $15,960. In the year 1905 the following quantities were reported: metallic paint and mortar color, 6059 short tons, valued at $70,090; slate pigment, 2929 short tons valued at $22,668. These quantities include only the output made within the State from local materials. A part of the crude material is shipped each year to points outside of the State for manufacture. An output of 9382 tons valued at $22,949 was reported by four firms who sell the crude ore or rock to paint grinders.

NATURAL GAS

There are 15 counties in the State in which natural gas was produced for lighting and heating purposes during the past year. The principal supplies were derived from the fields in Allegany, Cattaraugus, Chautauqua and Erie counties, the aggregate value of their output being about 85% of that for the whole State. It is gratifying to note that the production reported from the different fields, with some exceptions, has been gradually increasing of late years. This is due in part, no doubt, to the greater care with which the supply is now conserved and utilized, as compared with the wasteful methods once used; but it would also appear that the natural resources are not in danger of rapid exhaustion.

The gas pools are found at several horizons in the geological column, ranging from the Potsdam sandstone in the Cambric to the Chemung and Portage shales and sandstones of the Devonic. As a rule there is a definite horizon for each field, though some wells have yielded gas at different depths and from various rock formations. The Trenton limestone seems to be the lowest of the prolific strata from which gas has been obtained in large quantity. It affords the main supply in the wells of Oswego and Onondaga counties. The Medina sandstone has come into prominence lately by reason of the large pools that have been found in it in Erie county, now the most productive of the State. The wells recently put down at Silver Creek, Chautauqua co., are also bottomed in the Medina. The Portage and Chemung strata yield most of the gas produced at other localities along the shore of Lake Erie in Chautauqua co., and practically the entire output of Cattaraugus and Allegany counties.

One of the leading developments of the past year has been the opening of a promising field at Pavilion, in the southeastern part of Genesee county. Five wells were drilled by the Pavilion Natural Gas Co., and are reported to have given indications of a flow amounting to over 2,000,000 cubic feet a day. They are located on the Starr and Hooker farms. It is intended to drill additional wells during the present year. The company furnishes gas to the village of Pavilion and has laid a pipe line to Leroy for the purpose of supplying that place. A second company was formed and secured leases within the village where it drilled four wells, of which all but one were dry. The gas is found at a depth of from 1700 to 1850 feet in what is believed to be the Medina sandstone. A bed of rock salt 84 feet thick was penetrated in well no. 2 of the Pavilion Natural Gas Co.

At Seneca Falls, Seneca co., a well drilled by H. W. Knight encountered gas at 1450 feet. It was continued to a depth of 1617 feet, giving a flow estimated at 20,000 cubic feet a day.

Several wells have been drilled for oil and gas in the vicinity of Dansville, Livingston co., during the past few years without any success. Further exploration has been undertaken at a locality about 4 miles south of the village, and has resulted in the discovery of a gas horizon at 1200 feet. It is intended to continue drilling to 2500 feet.

The Cherry Creek Oil Co. located a very successful well near Cherry Creek, in eastern Chautauqua county. The flow at the outset was above 500,000 cubic feet and has averaged about 150,000 cubic feet a day. The gas is used in Cherry Creek.

The Frost Gas Co. of Fredonia, Chautauqua co., and the Welch Gas Co. of Westfield in the same county are new producers. The wells owned by the former company are situated at Sheridan. The Welch Gas Co. drilled one well to a depth of 2355 feet when a pool was encountered which gave a measured flow of 235,000 cubic feet a day, afterwards settling down to 100,000 cubic feet. The horizon is said to be the white Medina sandstone. The well is located in Westfield and has been connected with the village mains. The company has a second well under way which had reached a depth of 2000 feet at the close of the year.

The gas field at Silver Creek, Chautauqua co., which was first opened in 1904, continues to be very productive. It supplies Dunkirk, Forestville and Silver Creek. The South Shore Gas Co. and the Silver Creek Gas & Improvement Co. handle the output.

In Steuben county the North Side Gas & Oil Co. has been engaged in exploration at Ferenbaugh, 4 miles north of Corning. A flow of about 25,000 cubic feet was struck in the first well at a depth of 250 feet. The company will continue operations. At Keuka a test well was put down on the farm owned by E. Newman, resulting in the discovery of small pockets at depths from 60 to 210 feet. Owing to an inrush of water the well has not been commercially productive. The Tusco Oil, Mineral & Gas Co., operating at Woodhull, reported the discovery of gas, though no attempt was made to utilize the flow.

Yates county reported an output of gas for the first time in 1906. The Rushville Mining & Gas Co. drilled two wells during the preceding year which supply the village of Rushville.

The occurrence of natural gas near Voorheesville, Albany co., may be recorded, though there has been no commercial production. A well drilled for water opened a pocket in the Hudson River shales at 150 feet depth. The flow rapidly diminished.

Production. The value of the output of natural gas in 1906, as reported by the individual producers and pipe line companies, was $766,579. In 1905 the output was valued at $607,000 and in 1904 at $552,197. The gain for the year was thus about 26 per cent, while in the last years there has been an increase of nearly 50 per cent.

The quantity of gas produced in 1906 amounted to 3,007,086,000 cubic feet. In arriving at this total estimates are included for certain producers who were unable to supply exact figures, but, as it is only the smaller operators as a rule that do not keep records of their wells, the estimate is very close to the actual production. The quantity of gas yielded by the wells in 1905 is estimated at 2,639,130,000 cubic feet, and in 1904 at 2,399,987,000 cubic feet.

Production of natural gas

COUNTY	1904	1905	1906
Allegany-Cattaraugus	$183 830	$204 430	$247 208
Chautauqua	31 822	26 232	94 345
Erie	254 899	281 253	317 554
[a] Livingston	32 451	41 805	52 805
Onondaga	15 350	16 825	16 385
Oswego	14 990	13 583	13 182
[b] Wyoming	18 855	22 872	25 100
Total	$552 197	$607 000	$766 579

[a] Includes also Seneca, Schuyler, Steuben, Ontario and Yates counties.
[b] Includes also Niagara and Genesee counties.

The average value of the natural gas as given in the returns ranges from a minimum of 18 cents to a maximum of 50 cents a thousand cubic feet. The general average for the whole State during the last three years has been about 25 cents.

The largest relative increase in production during the past year was shown by Chautauqua county, with a total valued at $94,345 against $26,232 in 1905. Erie county reported an output valued at $317,554 as compared with $281,253 in the preceding year. There was also a notable increase in the fields of Allegany and Cattaraugus counties.

PEAT

The application of peat to industrial uses has continued to attract attention during 1906. As heretofore the main object in view has been to utilize the material for fuel purposes. The enterprises in New York State, however, have not been carried as yet beyond the experimental stage, and there were no plants making peat fuel on a commercial scale. A new feature of the subject that has come into prominence in the last year is the possibility of using peat for paper manufacture, a development suggested by recent work along this line that has been carried out in Europe.

The latest, as well as, perhaps, the most important experiments in the utilization of peat for fuel within the State has been started at Heuvelton, St Lawrence co. They are based on different principles than have heretofore been adopted for the purpose. The plant is installed on a boat, 125 feet long and 30 feet wide, which is self-propelling and carries all the machinery required for excavating the peat and converting it into marketable fuel. It is planned to operate on Black lake near Ogdensburg, where there are reported to be peat deposits at no great depths. The dredging apparatus consists of two conveyor chains that travel along inclined ways independently mounted and swinging so as to cover a width of 40 feet in front of the boat. The inclined ways can be raised or lowered as required, according to the depth from which it is necessary to dredge the peat. The latter is carried by the bucket chains into a hopper from which it is spouted to the first of the machines designed for its treatment, where it is mashed and kneaded. This machine breaks up the coarser material and at the same time expels a portion of the absorbed water. In the next process the peat undergoes a more thorough drying by heat. The drier resembles somewhat a horizontal water tube boiler and is made up of a large number of tubes arranged in tiers, the succeeding tubes of each tier sloping slightly in opposite directions. Steam is admitted around the tubes, while the peat is carried through them by special conveyors until it has made the entire circuit. After drying the peat is to be compressed into briquets or produced for use in gas producers. All the machinery is operated by electric power supplied by a boiler and engine that have been installed on the boat. The plant is built after the designs of Mr Walter T. Griffin who has also supervised its construction. It was not completed in time to be placed in operation before the close of the year.

The manufacture of peat into the heavier grades of paper, as are employed in making cartons, boxes, etc., was commenced year by the Pilgrim Paper Co., who have erected a plant at Capac, Mich. It is reported that very satisfactory results have been obtained during the short period of activity. A subsidiary company has been incorporated for the purpose of establishing the industry in New York State and has acquired for that purpose a tract of peat land near Oswego. The special machinery requisite in using peat fiber is made after the Esser patents which are owned in Vienna, Austria. A small proportion of wood pulp in the form of screenings or of newspaper is incorporated with the fiber. The finished product has a strong, smooth texture and is quite resistant to dampness or moisture in contrast with paper made from ordinary materials. The peat found in the vicinity of Oswego is well adapted for this use, owing to its perfectly fibrous condition and freedom from foreign matter. A carload of peat was also shipped from Glens Falls to Michigan for experimental purposes.

PETROLEUM

The petroleum industry of New York State shows few changes from year to year. There have been no important additions to the areas of the oil fields for some time, yet the output has been fairly well maintained as is evidenced by comparison of the annual totals which are included herewith. The stability of the industry may be ascribed largely to the fact that the oil pools when once tapped continue productive for a relatively long period. The increment from the new borings that are put down each year about counterbalances the decline in output from the old wells. At present the average daily yield of each well is less than one barrel. Pumping is generally resorted to and for this purpose gas engines, which are supplied from the natural gas that accompanies the petroleum, are used. From the storage tanks of the individual producers the oil is run into pipe lines for transport to the refineries. There are six pipe line companies operating in the State who handle practically all of the product.

The oil-bearing territory includes portions of Cattaraugus, Allegany and Steuben counties. It is the northernmost portion of the Appalachian field, which reaches its main development in the states of Pennsylvania, Ohio and West Virginia. The oil in the New York fields is associated with dark colored sandstones belonging to the Chemung formation of the Upper Devonic.

During the year 1906 a promising discovery of oil was made in the Short Tract district of northern Allegany county, where several wells have been drilled within the last five or six years, but without establishing the existence of oil in quantity. The well was put down on the Van Nostrand farm, 5 miles from Fillmore. At a depth of 568 feet oil began to flow under natural pressure but soon subsided. A yield of about 10 barrels a day has been secured by pumping. The product is an amber oil of light specific gravity. Further drilling has been undertaken to test the importance of the discovery.

In the Bolivar district of southwestern Allegany county, a possible enlargement of the known productive limits is indicated by recent drilling at a locality 8 miles south of the village of Bolivar. Several wells were opened last year for gas, and one of them tapped an oil-bearing stratum at 1000 feet depth, yielding about five barrels a day.

The output of petroleum in New York State amounted in 1906 to 1,043,088 barrels of 42 gallons, as compared with 949,511 barrels in the preceding year. The estimated value of the yield was $1,721,095, or an average of $1.65 per barrel. On the same basis the production in 1905 was valued at $1,566,931. In the compilation of the statistics for these years, as well as for 1904, the receipts of oil reported by the pipe line companies have been used. The list of companies is as follows: The Allegany Pipe Line Co., Columbia Pipe Line Co., Union Pipe Line Co., and Fords Brook Pipe Line Co., of Wellsville, and the Tide Water Pipe Co., Limited, of Bradford, Pa.

[a]Production of petroleum in New York

YEAR	BARRELS	VALUE
1891	1 585 030	$1 061 970
1892	1 273 343	708 297
1893	1 031 391	660 000
1894	942 431	790 464
1895	912 948	1 240 468
1896	1 205 220	1 420 653
1897	1 279 155	1 005 736
1898	1 205 250	1 098 284
1899	1 320 909	1 708 926
1900	1 300 925	1 759 501
1901	1 206 618	1 460 008
1902	1 119 730	1 530 852
1903	1 162 978	1 849 135
1904	1 036 179	1 709 770
1905	949 511	1 566 931
1906	1 043 088	1 721 095

---

[a] The statistics for the years 1891–1903 inclusive are taken from the annual volumes of the *Mineral Resources*.

PYRITE

There was a small output of pyrite from the St Lawrence cou mines during the past year. The quantity reported was 11,798 lo tons valued at $35,550, as compared with 10,100 long tons val at $40,465 in 1905. The production was rather incidental to preliminary work of development, than to regular mining.

The deposits in St Lawrence county have been under exploitat for several years, yet mining operations, hitherto, have had a des tory character without any stable or permanent basis. The m difficulty which seems to have prevented a successful issue of various undertakings started in this field has been the lack of a quate capital to open the mines and equip them for large sc operations. The problem involved is very similar to that of m netite mining in the Adirondacks.

The St Lawrence Pyrite Co., who took over the Stella mine Hermon, has inaugurated the most extensive, as well as, perha the most promising developments that have yet been undertak The company recently completed a 500 ton mill on the prope and has been engaged during the year in opening the mines supply an adequate output of ore. A railroad from the village Hermon to Dekalb Junction has been built by the company and v enable it to ship the ore by car direct from the mill. There are f ore deposits on the property, of which two are being worked.

The Cole mine near Gouverneur, formerly owned by the Adir dack Pyrite Co., has been taken over by the American Pyrites The mine has shipped in the past a considerable quantity of lu ore. It is equipped with a mill.

QUARTZ

Westchester county has contributed a small output of quartz e year. The mineral is obtained from veins where it occurs nea pure and also from pegmatite dikes in which it is mixed with fe spar. The product is used in part for pottery, being shipped manufacturers of these articles at Trenton, N. J.; it is also emplo in making wood filler and silicate paint. The Bridgeport W Finishing Co. of New Milford, Ct., and P. H. Kinkel of B ford, N. Y., were the only producers during the past year.

SALT

The salt production in the State has shown an increase of about 5 per cent for the past year. The total quantity of salt of all kinds mined or manufactured in 1906 as reported by the different companies, was 9,013,993 barrels of 280 pounds, on which a value of $2,131,650 was placed. The corresponding returns for 1905 aggregated 8,575,649 barrels with a valuation of $2,303,067 and those for 1904 amounted to 8,724,768 barrels with a value of $2,102,748. The output in 1906 exceeded the total reported for any previous year; the next largest production being that given for 1904.

The marketable grades of salt that are produced in New York include rock salt and the different varieties of brine salt known as coarse solar, common fine, table, dairy, agricultural and packers salt. In addition to the salt that is sold as such, a very large quantity is converted into soda products. The Solvay Process Co., at Solvay near Syracuse, manufactures such products directly from brine that is supplied by their own wells, and the amount of salt thus used is included in the statistics above reported.

The solar salt is made entirely in Onondaga county. Syracuse has long been the center of this branch of the industry which was first started in the vicinity in 1789. A natural brine with from 17 to 20 per cent sodium chlorid is employed. The brine is stored in glacial gravels and has evidently been formed by circulation of ground waters through adjacent beds of rock salt. Most of the wells are located on the Onondaga Reservation which is under State control. The brine is supplied to the individual evaporating plants at a fixed charge.

The manufacturers of brine salt at other localities in the State obtain their supplies from wells driven into the rock salt. Fresh water is introduced into the wells from the surface and pumped up after becoming nearly saturated. By this method a brine carrying about 25 per cent sodium chlorid may be secured, or within 1 per cent or so of the saturation point for water. The Tompkins county salt is thus obtained from depths exceeding 2000 feet.

Altogether there were 32 companies engaged in the production of salt in the State during the past year, as compared with 31 companies in 1905 and 30 in 1904. Of the total number, Onondaga county was represented by 21. The International Salt Co. operated four plants as follows: Ithaca works, Ithaca; Cayuga works, Myers; Glen works, Watkins; and Yorkshire works, Warsaw. The Hawley and Warsaw works at Warsaw owned by the company were inactive.

NAME	LOCATION
Granite Brick Co.	Glens Falls
Lancaster Sand-Lime Brick Co.	Lancaster
Newburgh Sand-Lime Brick Co.	Newburgh
Paragon Plaster Co.	Syracuse
Rochester Composite Brick Co.	Rochester
Roseton Sand-Lime Brick Co.	Roseton
F. W. Rourke & Co.	Brooklyn
Sand Stone Brick Co.	Schenectady
Schenectady Brick Co.	Schenectady
Watertown Sand Brick Co.	Watertown

SLATE

Quarries of roofing slate are worked in Washington county near the Vermont state line. The productive district includes a narrow belt running nearly due north from Salem through the towns of Hebron, Granville, Hampton and Whitehall. Efforts have been made to work slate in other parts of the State, particularly in the Hudson river metamorphic region, but for reasons no longer apparent they have not led to the establishment of a permanent industry. Hoosick, Rensselaer co., New Lebanon, Columbia co., and New Hamburg, Dutchess co., are among the places that have furnished slate in the past. At the locality last named, beds were found which yielded large blocks resembling the Welsh slate in color and quality and adapted for structural material, billiard tables, blackboards and other purposes. They were operated as late as 1898.

The slate from Washington county exhibits a variety of colors. Red is the most valuable and is the characteristic product of the region. Owing to its rarity elsewhere, it has a wide sale and is in constant demand for export. This variety is found near Granville and in the Hatch Hill and North Granville districts between North Granville and Whitehall. Its occurrence is confined to areas of Lower Siluric age. Purple, variegated and different shades of green slate are produced from Cambric areas, principally around Middle Granville, Salem and Shushan. The unfading green which likewise commands a good price for roofing purposes, is quarried to some extent in Washington county, but the greater quantity comes from across the border in Vermont.

Up to the present time the production of slate for other than roofing purposes, such as mantels, billiard tables, floor tiling, blackboards, etc., has not been developed to any extent in this section. It is an important branch of the slate trade of Pennsylvania and Vermont, and there is no doubt that increased attention to this branch would greatly assist the advancement of the industry.

The output of slate in New York State last year amounted in value to $61,921, consisting of roofing slate $57,771 and mill stock $4150. The number of squares of roofing slate made was 16,248. In 1905 the output was valued at $95,009 and comprised 16,460 squares of roofing slate valued at $94,009 and $1000 mill stock. The average value of roofing slate for the year was $3.56 a square, against $5.71 a square in 1905. The smaller value last year was due to the relatively light production of red slate, as compared with the cheaper grades.

STONE

The quarry products of New York State rank next in importance to clay manufactures. All of the principal varieties of building and ornamental stones are quarried and most of them on an extensive scale. The production, however, falls short of meeting the requirements for many kinds of stone. Large quantities of granite, marble and limestone are brought in from adjoining states or are imported from foreign countries. With the enormous undeveloped resources, there is abundant opportunity for development of the quarry industries to a scale more nearly commensurate with the market demands.

The statistics and notes incorporated in the following pages relate to the different quarry industries of the State, except those of slate, marl and millstones. Information regarding the slate and millstone industries will be found under their own titles, elsewhere in this report.

Production of stone

The value of the quarry materials produced in 1906 amounted in the aggregate to $6,504,165. The total for the preceding year was $6,107,147, showing a gain of $397,018. The value of the limestone quarried was $2,963,829, against $2,411,456 in 1905. The sandstone was valued at $1,976,829, the greater part contributed by the companies engaged in the bluestone trade. In 1905 the sandstone amounted to a value of $2,043,960. The output of trap from the Hudson river Palisades, and Richmond and Saratoga counties was valued at $847,403, against $623,219 in the preceding year. Marble accounted for a value of $460,915, considerably less than the total reported for 1905 which was $774,557. There was little change in the granite industry, the value of the output amounting to $255,189 against $253,955 in 1905.

Classified as to uses, crushed stone was the largest item in the total, with an aggregate value of $2,435,493, an increase of more than $500,000 over the amount returned for 1905. The use of

Production of granite

MATERIAL	1904	1905	1906
Building stone	$89 300	$139 414	$231 190
Monumental	11 262	10 431	4 119
Crushed stone	83 295	69 748	13 980
Rubble, riprap	30 760	30 125	2 423
Other kinds	7 265	4 237	3 477
Total	$221 882	$253 955	$255 189

Limestone

The limestone quarries are first in importance among the stoneworking industries of the State. Compared with sandstone, which ranks second in value of output, limestone is not so extensively used as a building material, but it finds more extensive employment for road metal and concrete. Its wide occurrence, in connection with natural fitness for the purpose, has favored the development of a large crushed stone business that covers nearly every section of the State. The manufacture of lime also calls for a large part of the product.

The noncrystalline limestones, which alone are considered under this head, comprise a variety of rocks as regards their geological occurrence and physical and chemical characters. They are distributed among the Cambric, Lower Siluric, Siluric and Devonic systems. In chemical composition they include every gradation from practically pure lime carbonate to magnesian limestones and dolomites and to silicious, aluminous or ferruginous types in which the

Production of limestone

MATERIAL	1904	1905	1906
Crushed stone	$994 475	$1 193 800	$1 590 205
Lime made	678 225	702 684	795 348
Building stone	248 617	246 300	229 479
Furnace flux	121 109	198 168	287 816
Rubble, riprap	22 230	40 664	32 975
Flagging, curbing	6 253	7 297	8 067
Miscellaneous	33 150	22 543	19 939
Total	$2 104 095	$2 411 456	$2 963 829

carbonates play a subordinate rôle. Light colored and white limestones are not typical of the State, the prevailing colors being grayish or drab, and for this reason considerable quantities are brought in from other states, principally Ohio and Indiana.

The total output of limestone last year amounted in value to $2,963,829. This is exclusive of the products used in the Portland and natural cement industries, for which no statistics have been collected. Compared with the previous year, there was a gain of $552,373 in the valuation, or about 23 per cent. The product was distributed among 33 counties of the State, with a total of over 160 quarries.

Crushed stone for road metal, concrete, etc., represents the largest item in the output. The value of this material was $1,590,205, against $1,193,800 for 1905. The manufacture of lime is second in importance with a product valued at $795,348 and $702,684 for the respective years. The building stone quarried amounted to a value of $229,479 against $246,300 in 1905; furnace flux to $287,816 against $198,168; rubble and riprap to $32,975 against $40,664; flagging and curbing to $8067, against $7297; and miscellaneous materials, not classified in the returns, to $19,939 against $22,543 in the preceding year.

Distributed according to the counties in which the limestone was quarried, the largest producer last year was Erie county which reported an output valued at $525,381, consisting principally of building stone, crushed stone and furnace flux. This county also ranked first on the list in 1905 with a valuation of $383,411. Onondaga county which returned a total value of $391,457 was second, the same position as in the preceding year when its output amounted to $310,322. It is the largest manufacturer of lime. The remaining counties which reported a value of over $100,000 each with their respective totals are here given, the figures in brackets being the corresponding totals for 1905: Dutchess, $368,927 [$234,578]; Rockland, $242,184 [$220,596]; Genesee, $227,062 [$227,087]; Warren, $205,832 [$192,136]; Westchester, $143,168 [$74,948]; and Albany, $106,800 [$101,425].

Lime. There were 38 firms that reported an output, last year, of limestone (including marble) for lime burning, either as a main product or in connection with the quarrying of other materials. T greater portion of the limestone was converted by the con operating the quarries. In all 18 counties participated in the p duction. The quantity of lime made was 313,369 short t valued at $795,348. Onondaga county reported a product of

250 tons, or about 66 per cent. In the previous year the output amounted to 323,905 short tons, valued at $702,684, of which Onondaga county contributed 193,506 tons. The importance of the industry in this county is to be ascribed to the operations of the Solvay Process Co. which uses the lime as a reagent in the manufacture of soda products.

The production in the other leading counties for 1906 and 1905 respectively was as follows: Warren, 39,076 [38,025] tons; Clinton, 16,400 [16,000]; Washington, 12,000 [12,000]; and Lewis, 9500 [8557].

It will be noted that the value of the production as given above is considerably less than the ruling commercial price; this is due to the fact that a nominal valuation has been placed upon the portion used as a chemical reagent. Disregarding the quantities thus consumed, the value of the lime averaged $4.58 per short ton in 1906 and $3.58 in 1905.

Crushed stone. Limestone is more widely employed in New York State for crushing than any other kind of stone. The total production in 1906 amounted to 2,194,547 cubic yards valued at $1,590,205, as compared with 1,851,008 cubic yards valued at $1,193,800 in the preceding year. Of the quantities given, 486,750 cubic yards in 1906 and 573,924 cubic yards in 1905 were returned as having been used for road metal, though the actual amount thus used probably exceeded these totals since some plants do not keep any records as to the disposal of their product.

The leading counties in the production of crushed stone with their outputs are as follows, the figures for 1905 being bracketed: Dutchess, 400,177 [335,112] cubic yards; Rockland, 373,387 [335,714]; Genesee, 323,128 [288,000]; Erie, 289,110 [243,628]; Albany, 150,000 [131,000]; Westchester, 105,441 [43,926]; and Onondaga, 92,950 [84,811].

Building stone. The production of limestone for building purposes has remained comparatively steady during recent years. The value of the material quarried in 1906 was $229,479, against $246,300 in 1905. Erie county maintains the largest quarries of building stone, its output amounting to a value of $118,806 as compared with $103,763 in the preceding year. The remaining counties are small producers. The output each year is supplemented by large quantities of limestone that are brought in from other states.

Furnace flux. The metallurgical industries of the State consume limestone as a flux in smelting operations. The largest users are the iron blast furnaces located in Buffalo and vicinity. The supply for this district is obtained from the outcrop of the Onondaga limestone in western New York and the adjacent part of the province of Ontario. The principal New York quarries are located at Clarence and Gunnville, Erie co., and at North Leroy, Genesee co. Flux is also obtained at West Chazy, Clinton co., and near Port Henry, Essex co., for use in the Adirondack iron furnaces, and at Oriskany Falls, Oneida co., for the iron furnace at Franklin Springs. The total production of limestone flux in 1906 amounted to 400,002 long tons valued at $229,479. In the preceding year the amount was 393,667 long tons, valued at $198,168.

Production of limestone by counties in 1905

COUNTY	CRUSHED STONE	LIME MADE	FURNACE FLUX	BUILDING STONE	OTHER USES	TOTAL
Albany.......	$90 800	$9 600	....	$525	$500	$101 425
Cayuga.......	13 227	....	$240	9 650	11 500	34 617
Clinton.......	4 600	58 000	5 200	9 105	....	76 905
Dutchess.....	234 578	....	....	....	....	234 578
Erie..........	153 736	497	96 626	103 763	28 789	383 411
Fulton.......	4 552	11 796	....	....	....	16 348
Genesee......	127 000	13 260	81 516	2 211	3 100	227 087
Herkimer.....	5 412	5 913	....	30	1 020	12 375
Jefferson......	3 951	43 000	....	6 154	4 650	57 755
Lewis........	1 432	28 306	....	658	234	30 630
Madison......	38 109	....	....	5 259	622	43 990
Monroe.......	37 404	....	....	8 036	351	45 791
Montgomery..	60 385	....	115	7 216	....	67 716
Niagara......	10 949	4 500	....	3 055	....	18 504
Oneida.......	17 243	....	....	1 500	....	18 743
Onondaga....	39 832	234 308	5 550	17 984	12 648	310 322
Rockland.....	220 596	....	....	....	....	220 596
St Lawrence...	940	9 650	....	2 249	3 185	16 024
Saratoga......	8 500	....	....	3 065	205	11 770
Schoharie.....	17 246	....	50	49 227	272	66 795
Seneca.......	20 330	360	37	3 918	368	7 013
Warren.......	9 463	171 556	....	10 540	577	192 136
Washington...	39 312	51 000	....	175	....	90 487
Westchester...	30 748	43 900	300	....	....	74 948
Other counties[a].......	21 455	17 038	8 534	1 980	2 483	51 490
Total.....	$1 193 800	$702 684	$198 168	$246 300	$70 504	$2 411 456

[a] Includes Columbia, Essex, Greene, Ontario, Orange, Orleans, Rensselaer, Schenectady, Ulster, Wayne and Yates.

Production of limestone by counties in 1906

COUNTY	CRUSHED STONE	LIME MADE	FURNACE FLUX	BUILDING STONE	OTHER USES	TOTAL
Albany	$96 200	$9 600		$500	$500	$106 800
Cayuga	23 098		$300	11 000	3 000	37 398
Clinton	8 350	61 500	15 900	7 175	4 000	96 925
Dutchess	368 927					368 927
Erie	222 384	375	172 550	118 806	11 266	525 381
Fulton	6 963	9 200				16 163
Genesee	142 342	14 000	69 650	1 070		227 062
Greene	1 785		186	24 500	15 500	41 971
Herkimer	4 000	6 300		810		11 110
Jefferson	4 875	42 250		6 053	499	53 677
Lewis	635	47 000		824	1 025	49 484
Madison	20 184			90	1 320	21 594
Monroe	52 295			7 564	547	60 406
Montgomery	55 235			4 116	1 297	60 648
Niagara	2 400	40		3 425	10 716	16 581
Oneida	32 000		12 600	15 000		59 600
Onondaga	63 986	313 500	3 420	8 976	1 575	391 457
Rockland	242 184					242 184
St Lawrence		9 040	3 311	800	911	14 062
Saratoga	13 000			3 000		16 000
Schoharie	21 073	300		10 825	7 875	40 073
Seneca	3 301	800	100	2 025	100	6 326
Warren	13 347	190 665		1 370	450	205 832
Washington	36 000	48 000			400	84 400
Westchester	105 441	36 766	711	250		143 168
*a*Other co'nties	50 200	6 012	9 088	1 300		66 600
Total	$1 590 205	$795 348	$287 816	$229 479	$60 981	$2 963 829

a Includes Columbia, Essex, Ontario, Orange, Rensselaer, Schenectady, Ulster, Wayne and Yates counties.

Marble

The granular crystalline limestones and dolomites which are classed as marble occur in the Adirondack region and in the southeastern part of the State. They are mainly associated with metamorphosed Precambric strata. A few varieties of compact limestones, such as the Trenton limestone at Glens Falls and the Chazy limestone of Clinton county, possess ornamental qualities that fit them for special uses and are included under this head.

The quarrying of monumental marble is practically limited to the region about Gouverneur, St Lawrence co. The industry has been established here for many years, and the product has a wide sale. The marble varies from nearly white to dark bluish gray, the dark varieties being the more valuable. As only the best selected stone can be used for monumental work, the poorer grades are dressed into blocks for building and construction purposes.

In southeastern New York the quarries are worked mainly for building stone which is supplied to New York city and other markets in the east. White and gray marbles are the characteristic products. Greenport, Columbia co., South Dover, Dutchess co., and Ossining, Dobbs Ferry, White Plains, Oscawana, Pleasantville and Tuckahoe, Westchester co., are some of the quarry localities.

Production of marble

VARIETY	1904	1905	1906
Building marble	$278 994	$571 810	$337 365
Monumental	154 673	177 557	99 100
Other kinds	45 104	25 190	24 450
Total	$478 771	$774 557	$460 915

The production of marble reported by 13 producers amounted in 1906 to a value of $460,915, divided as follows: building marble, rough and dressed, $337,365; monumental marble, rough and dressed, $99,100; other kinds, $24,450. There was a large falling off in the production as compared with the preceding year when the output was valued at $774,557. This was due principally to the smaller demand for building stone in New York city. The value of the marble quarried in southeastern New York aggregated $260,350 against $464,247 in 1905. St Lawrence county reported an output valued at $136,835 against $265,722.

The quarries at South Dover formerly worked by the Dover Chemical & Quarry Co. have been taken over by the Exploitation Co. of America, with a view to reopening them to supply building stone. Development work was prosecuted during the past year and it is intended to begin shipments during the current season. Drill cores show that there is a large quantity of stone available, similar to the marble quarried by the South Dover Marble Co. which finds much favor as a building material. An analysis of the marble, made by E. F. Briggs, has been furnished by the present company and is here given.

Lime (CaO)	31.36
Magnesia (MgO)	19.41
Carbon dioxid (CO_2)	45.83
Insoluble	3.40
	100.00

Sandstone

Under the head of sandstone are included the sedimentary rocks which consist of quartz grains bound together by some cementing substance. Among the principal varieties distinguished by textural characters are sandstones proper, conglomerates, grits and quartzites.

The wide distribution of sandstones in the geologic series of New York State has given them great importance as economical sources of structural materials and in point of annual output they rank second only to limestone. Nearly all of the main formations above the Archean contain these rocks at one or more horizons. The sandstones that are chiefly quarried in New York are the Potsdam, Hudson River, Medina, and the Devonic sandstones. A few quarries have been opened in the Shawangunk conglomerate and the Clinton sandstone. Bluestone is a popular term for the fine grained, evenly bedded sandstones found in the Devonic which have a special application for flagging and curbing and to a lesser extent for building stone.

Production of sandstone

The total value of the sandstone quarried in New York last year was $1,976,829 as compared with $2,043,960, the value of the output in 1905. The output was distributed among 35 counties with an aggregate of over 400 producers. Classified as to uses the total was distributed as follows: building stone, rough, $343,077; building stone, dressed, $267,472; curbing, $553,085; flagging, $438,526; paving blocks, $282,063; crushed for roads, $14,677; crushed for other uses, $36,528; rubble, etc., $11,661; all other purposes, $29,740.

The following tables show the value of the production of sandstone in 1905 and 1906, distributed among the leading districts of the State.

Production of sandstone in 1905

DISTRICT	BUILDING STONE	CURBING AND FLAGGING	PAVING BLOCKS	CRUSHED STONE	RUBBLE, RIPRAP	ALL OTHER
Bluestone						
Hudson river...	$59 813	$314 791	$6 165	....	....	$2 000
Delaware river .	64 084	441 634	2 500	....	$4 400	....
Chenango co...	70 066	76 983	988	....	2 168	5 473
Wyoming co...	171 620	3 000	....	....	930	33 433
Other districts..	36 210	59 641	587	$1 102	374	11 282
Total bluestone.	$401 793	$896 049	$10 240	$1 102	$7 872	$52 188
Sandstone						
Orleans county.	$71 679	$119 390	$270 964	$1 282	$3 500	$51 290
Other districts..	57 013	14 474	29 565	35 022	16 345	4 192
Total sandstone.	$128 692	$133 864	$300 529	$36 304	$19 845	$55 482
Combined total.	$530 485	$1 029 913	$310 769	$37 406	$27 717	$107 670

Production of sandstone in 1906

DISTRICT	BUILDING STONE	CURBING AND FLAGGING	PAVING BLOCKS	CRUSHED STONE	RUBBLE, RIPRAP	ALL OTHER
Bluestone						
Hudson river...	$70 816	$220 961	$14 228	....	....	....
Delaware river..	110 008	572 470	1 350	700	1 188	....
Chenango co....	85 576	41 985	....	....	2 678	....
Wyoming co...	234 280	....	....	550	843	140
Other districts..	12 658	4 247	....	2 770	....	325
Total bluestone.	$513 338	$839 663	$15 578	$4 020	$4 709	$465
Sandstone						
Orleans county.	$50 845	$147 438	$260 878	$225	$552	$25 000
Other districts..	46 366	4 510	5 607	46 960	6 400	4 275
Total sandstone.	$97 211	$151 948	$266 485	$47 185	$6 952	$29 275
Combined total.	$610 549	$991 611	$282 063	$51 205	$11 661	$29 740

The value of bluestone quarried for all purposes in 1906 $1,377,773 or approximately 70 per cent of the total san the value of the other sandstone quarried was $599,056 or cent of the total. The returns show that there was a fall

TALC

The St Lawrence county mines reported an output in 1906 of 64,200 short tons valued at $541,600. The yield was somewhat less than in the preceding year, when the total was 67,000 short tons, but the value showed a notable increase due to the higher range of prices. The average selling price for the year on the basis of carload lots was $8.43 a ton, as compared with $7.75 a ton in 1905. The following table gives the annual production and value by years for the period 1896–1906, the figures previous to 1904 being taken from the volumes of the *Mineral Resources*.

Production of talc in New York

YEAR	SHORT TONS	VALUE	VALUE PER TON
1896	46 089	$399 443	$8 67
1897	57 009	396 936	6 96
1898	54 356	411 430	7 57
1899	54 655	438 150	8 02
1900	63 500	499 500	7 87
1901	62 200	483 600	6 99
1902	71 100	615 350	8 65
1903	60 230	421 600	7 ..
1904	65 000	455 000	7 ..
1905	67 000	519 250	7 75
1906	64 200	541 600	8 43

A further consolidation of the mining and milling interests in the talc district was effected during the year by the International Pulp Co., the largest of the producers. Since its organization in 1893 the company has exercised a controlling influence over the industry, though it has not been without active competition from rival concerns. At the time it was formed the properties of the St Lawrence Pulp Co., the Natural Dam Pulp Co., the Agalite Fibre Co. and Adirondack Pulp Co. were acquired and in the following year those of the Asbestos Pulp Co. were also secured. The company thus came into possession of all of the then active interests except the United States Talc Co., which was taken over in August 1906. The latter owned a mine west of Talcville and a mill near Dodgeville. The mill has been recently enlarged by the addition of two cylinders and will restore partially the impairment of productive facilities with which the International Co. met during the past year in loss by fire of its Hailesboro mill. This mill was the largest and perhaps the best equipped of any in the district. It had a capacity of 75 tons a day. The company also owns three other mills situated at Talcville near its mines.

The Union Talc Co. and the Ontario Talc Co. have been the only producers in recent years aside from those mentioned. It has been reported that both companies have also come under the control of the International Pulp Co. through recent purchase of the capital stock. The Ontario Talc Co. owns three mines and a mill near Fullerville in the central part of the district. The Union Talc Co. has been the largest independent operator since 1900. It was organized as a consolidation of the Columbian Talc Co., American Pulp Co. and Keller Bros., and came into possession of three mines and an equal number of mills. The American mill near Fowler was burned down in December 1905.

A new company was incorporated late in the year for the purpose of mining and manufacture of talc in the St Lawrence county district. According to present plans, the company proposes to work the Freeman mine which has been under lease to the International Pulp Co. A water power on the Oswegatchie river near Dodgeville has been secured, and it is planned to erect a mill of 75 tons daily capacity.

ZINC AND LEAD

The deposits of zinc ore near Edwards, St Lawrence co., have not been worked during the past year. The inactivity has been due to causes which in no way reflect upon the value of the property, and there is a prospect that they will soon be removed and operations resumed once more. The developments thus far have been of the most promising character.

It seems probable that the occurrence is closely related to the pyrite deposits which are found in the schists at Hermon, Gouverneur and other localities in St Lawrence county and which at times carry a small quantity of zinc blende. The schists are metamorphosed Precambric sediments and are generally associated with crystalline limestone of the same character as the wall rock at the zinc mines. The analogy between the two types of deposits is further emphasized by the presence of pyrite in considerable quantity in the zinc ore.

The deposits of zinc blende occur as replacements of the limestone along or near the contact with a laminated gneiss. They are at times disseminated through the limestone resulting in a lean ore o mixed blende and gangue gradually shading off into the count rock, and again are concentrated in zones which are sharply bou and have the appearance of veins. The limestone contains serpentine nodules that have been derived by alteration from a nonhydrous silicate probably pyroxene. The mineralization is no doubt due to underground circulations. These have found passage along the contact between the gneiss and limestone and to a lesser extent along fissures within the limestone. It may be noted that the extensive talc deposits of this section occur on the same limestone belt and in the immediate vicinity of the zinc ore bodies. As has been demonstrated by Prof. C. H. Smyth jr, the talc owes its origin to the influence of subterranean waters acting upon masses of tremolite and pyroxene in the limestone. The evidence is insufficient to justify at present anything as to the precise manner in which the zinc blende has been deposited.

Some work was done during the year on a deposit of galena situated near Pierces Corners, St Lawrence co. The property was worked several years ago, but was abandoned after a little exploration. The former shaft which was bottomed at 80 feet has been pumped out and will be deepened at least 100 feet additional. The work is being done by the Independent Lead Co., of New York city.

The lead mine near Otisville, Orange co., formerly owned by the Washington Mining Co., has been taken over by the Phoenix Lead Co. of Paterson, N. J. It was developed to some extent last year, and it is proposed to instal machinery for continuing the work during the present season.

INDEX

Acid-proof brick, 16.
Adirondack Mining & Milling Co., 26, 27.
Adirondack Pulp Co., 70.
Adirondack Pyrite Co., 52.
Adirondacks, garnet, 25; graphite, 26; hematite, 37; magnetite, 30; marble, 64; pyrite, 52; titaniferous magnetite, 30, 34; trap, 68.
Agalite Fibre Co., 70.
Akron, cement industry, 13.
Akron Cement Works, 14.
Akron Gypsum Co., 28.
Alabama, gypsum, 28.
Albany county, bluestone, 68; building brick, 18, 20; clays, 16, 17; crushed stone, 62; drain tile and sewer pipe, 21; fire brick and stove lining, 21; limestone, 61, 63, 64; natural gas, 47; potteries, 23; terra cotta, fireproofing and building tile, 21.
Algonquin Red Slate Co., 45.
Allegany county, building brick, 18; clays, 17; natural gas, 46, 48; petroleum, 50; terra cotta, fireproofing and building tile, 21.
Allegany Pipe Line Co., 51.
Alvord, E. B. & Co., 28.
Amenia Co., 30.
American Glue Co., 25.
American Graphite Co., 26, 27.
American Gypsum Co., 28.
American Pulp Co., 71.
American Pyrites Co., 52.
Anorthosite, 59.
Arnold, magnetite, 30.
Arnold hill, iron ore, 33.
Arnold Mining Co., 30, 33.
Arsenical ore, 10-12; analysis, 11.
Arsenopyrite, 10, 12.
Asbestos Pulp Co., 70.
Ashley, Dominic, 25.
Ausable Forks, monumental stone, 59.

Barton, H. H. & Son Co., 25.
Beck, L. C., cited, 12, 36.
Bedford, feldspar, 24; quartz, 52.
Benson mines, 6, 31.
Blue Corundum Mining Co., 24.
Bluestone, 66, 68; value of production, 57, 67.
Bolivar, petroleum, 51.
Borst, C. A., iron mine, 30, 42, 43, 44.
Bradford, Pa., petroleum, 51.
Brick, number made, 6; prices, 20-21; average price received, 19; production, 8, 9, 10, 14, 15, 18-21; value of production, 6, 8, 9, 10, 16, 18-21. *See also* Sand-lime brick.
Bridgeport Wood Finishing Co., 52.
Briggs, E. F., analysis, 65.
Brinsmade, Robert B., cited, 37.
Broome county, bluestone, 68; building brick, 18; clays, 17.
Brown Clay Works, 22.
Buffalo, furnace flux, 62.
Buffalo Cement Co., 14.
Building brick, *see* Brick.
Building stone, 57-69; value of output, 7, 58; production of granite, 59, 60; production of limestone, 60, 61, 62, 63; production of sandstone, 66, 67.
Building tile, *see* Tile.
Burhans, W. M., 22.

Cady & Vandenbergh, 22.
Caledonia mine, 37-39.
Camillus shale, 27.
Capac, Mich., peat manufacture, 50.
Carbon, dioxid, 12-13.
Carbonate, 29.
Catskill series, 45.

Cattaraugus county, natural gas, 46, 48; petroleum, 50; shale, 45.
Cayuga county, building brick, 18; clays, 17; drain tile and sewer pipe, 21; gypsum, 27; hematite, 30, 42; iron mines, 6; limestone, 63, 64.
Cement, 7, 13-14.
Champion Natural Carbonic Acid Gas Co., 12.
Champlain Graphite Co., 26.
Champlain Stone & Sand Co., 69.
Chateaugay Ore & Iron Co., 30.
Chautauqua county, building brick, 18; clays, 17; drain tile and sewer pipe, 21; fire brick and stove lining, 21; natural gas, 46, 47, 48; paving brick, 21; potteries, 23; terra cotta, fireproofing and building tile, 21.
Chazy limestone, 64.
Cheever mine, 6, 31, 33-34.
Chemung beds, 45, 46.
Chemung county, building brick, 18; clays, 17.
Chenango county, bluestone, 67, 68.
Cherry Creek, natural gas, 47.
Cherry Creek Oil Co., 47.
Clarence, furnace flux, 63.
Clay, 14-24; crude, 8, 9, 10, 24.
Clay materials, production, 15-17; new manufacturers, 21-22.
Clay products, 6, 8, 9, 10.
Clinton, hematite, 30, 42-43, 44.
Clinton county, building brick, 18; Chazy limestone, 64; clays, 17; furnace flux, 63; granite, 59; lime, 62; limestone, 63, 64; monumental stone, 59; trap, 68.
Clinton hematite, 40-43.
Clinton Metallic Paint Co., 45.
Clinton Point Stone Co., 69.
Clinton sandstone, 66.
Cole mine, 52.
Columbia county, building brick, 18, 20; clays, 16, 17; marble, 65; slate, 56.
Columbia Pipe Line Co., 51.
Columbian Talc Co., 71.
Concrete, made from limestone, 60.
Conduit pipes, 16.
Conklingville, graphite, 27.
Corwin & McCullough, 22.
Crane mountain, ocher, 45.
Crown Point Graphite Co., 26.
Crushed stone, 57-58; value of output, 7, 57, 58; made from granite, 59, 60; made from limestone, 60, 61, 62, 63; made from sandstone, 66, 67; made from trap, 69.
Cummings Cement Co., 13.
Curbing, value of output, 7, 58; made from granite, 59; made from limestone, 60, 61; made from sandstone, 66, 67.
Cuylerville, salt, 54.

Dansville, oil and gas, 47.
Dean mine, 30, 36-37.
Delaware county, bluestone, 68; shale, 45.
Delaware river district, bluestone, 67, 68.
Delft, 23.
Dickson mine, 39-40.
Diorite, 59.
Dobbs Ferry, marble, 65.
Dodgeville, talc, 70, 71.
Dover Chemical & Quarry Co., 65.
Drain tile, value of production, 15-16; manufacture, 21.
Dunkirk, potteries, 23.
Dutchess county, building brick, 18, 20; clays, 16, 17; crushed stone, 62; limestone, 61, 63, 64; limonite, 30; marble, 65; slate, 56.

Eagle Bridge, red slate, 45.
Earthenware, manufacture, 23; value of production, 23.
Edenville, arsenopyrite, 12.
Edwards, zinc, 71.
Electric and sanitary supplies, 23.
Electric City Clay Brick Co., 22.
Elko Paint Co., 45.
Emery, 8, 9, 10, 24.
Emmons, Ebenezer, cited, 34.
Empire Graphite Co., 27.

Erie county, building brick, 18; building stone, 62; cement industry, 13, 14; clays, 16, 17; crushed stone, 62; drain tile and sewer pipe, 21; fire brick and stove lining, 21; furnace flux, 63; gypsum, 27; limestone, 61, 63, 64; natural gas, 46, 48; potteries, 23; terra cotta, fireproofing and building tile, 21.
Esopus stone, 43.
Essex county, arsenopyrite, 10, 12; furnace flux, 63; garnet, 25; graphite, 26; iron mines, 6; titaniferous magnetites, 30, 31, 34; trap, 68.
Exploitation Co. of America, 65.

Fair Haven Iron Co., 6, 30, 42.
Feldspar, 8, 9, 10, 24–25
Ferenbaugh, natural gas, 47.
Fire brick, value of production, 15, 16; manufacture, 21.
Fire tile and shapes, 16.
Fireproofing, 21; value of production, 6, 16.
Flagging, value of output, 7, 58; from limestone, 60, 61; from sandstone, 66, 67.
Flue lining, 16.
Flux, *see* Furnace flux.
Foote, W. T., 34.
Fords Brook Pipe Line Co., 51.
Forest of Dean Iron Ore Co., 36.
Forest of Dean mine, 30, 36–37.
Franklin Iron Manufacturing Co., 30, 40, 42, 43.
Franklin mines, 42–43.
Franklin Springs, 63.
Fredonia, natural gas, 47.
Freeman mine, 71.
Front brick, value of production, 16.
Frost Gas Co., 47.
Fullerville, talc, 71.
Fulton county, clays, 17; granite, 59; limestone, 63, 64.
Furnace flux, 59; made from limestone, 60, 61, 62–63.
Furnaceville Iron Co., 30, 41, 42, 44.

Galena, 72.
Garbutt, wall plaster, 28.
Garnet, production, 7, 8, 9, 10, 25–26.
Garnet peak, 25.
Genesee county, crushed stone, 62; drain tile and sewer pipe, 21; furnace flux, 63; gypsum, 27, 28, 29; limestone, 61, 63, 64; natural gas, 46; salt, 54; terra cotta, fireproofing and building tile, 21; wall plaster, 28.
Geysers Natural Carbonic Acid Gas Co., 12.
Glass sand, production, 8, 9, 10.
Glens Falls, Trenton limestone, 64.
Glens Falls Cement Co., 13.
Glens Falls Graphite Co., 27
Gneisses, 59.
Gore mountain, garnet, 25.
Gouverneur, marble, 64; pyrite, 71.
Granite (village), millstones, 44.
Granite, 8, 9, 10, 59–60; value, 57, 58.
Granite Brick Co., 56.
Granville, slate, 56.
Graphite, 7–8, 9, 10, 26–27.
Greene county, bluestone, 68; building brick, 18, 20; clays, 17; limestone, 64; paving brick, 21.
Greenfield, graphite, 27; trap, 69.
Greenport, marble, 65.
Griffin, Walter T., 49.
Gunnville, furnace flux, 63.
Gurnee, H. M., 69.
Gypsum, production, 7, 8, 9, 10, 27–29.

Hague, graphite, 26.
Hammondville district, titaniferous magnetite, 31.
Hampden Corundum Wheel Co., 24.
Hampton, slate, 56.
Hansell, N. V., cited, 32.
Harlem Valley Brick & Supply Co., 22.
Hartnagel, C. A., Clinton hematite, 40–43.
Haverstraw quarries, 69.
Haverstraw Trap Rock Co., 69.
Hebron, slate, 56.

Hematite, 29, 30, 37; Clinton hematite, 40–43; used for metallic paint, 44, 45.
Herkimer county, granite, 59; iron mines, 6; limestone, 63, 64; shale, 45.
Hermon, pyrite, 52, 71.
Heuvelton, peat, 49.
Hoosick, slate, 56.
Hudson Iron Co., 30, 36.
Hudson river district, bluestone, 67, 68; building brick, 19.
Hudson River sandstone, 66.
Hudson River shales, 48.
Hunt, George W., 22.
Hurd, A. J., 45.
Hydraulic cement, production, 7.

Independent Lead Co., 72.
International Pulp Co., 70, 71.
International Salt Co., 53.
Iron-mining industry, progress, 6.
Iron ore, 8, 9, 10, 29–43.
Ithaca, salt, 53.

Jamesville, gypsum, 28.
Jefferson county, building brick, 18; clays, 17; granite, 59; hematite, 30, 37; limestone, 63, 64.

Keeseville, garnet, 25.
Keller Bros., 71.
Kemp, J. F., cited, 34.
Kerhonkson, millstones, 44.
Kerr Salt Co., 54.
Keuka, natural gas, 47.
Keystone Emery Mills, 24.
Kings county, clays, 16, 17; drain tile and sewer pipe, 21; fire brick and stove lining, 21; potteries, 23; terra cotta, fireproofing and building tile, 21.
Kingston, millstones, 44.
Kinkel, P. H., 24, 52.
Knight, H. W., 47.
Kyserike, millstones, 44.

Lake Sanford, titaniferous magnetite deposits, 6, 30, 34–36.
Lancaster, J. R., 24.
Lancaster Sand-Lime Brick Co., 56.
Lead, 71–72.
Lehigh Portland Cement Co., 28.
Leroy, gypsum, 29.
Leucopyrite, 10.
Lewis, arsenopyrite, 12.
Lewis county, lime, 62; limestone, 63, 64.
Lime, 59, 60, 61–63.
Limestone, 8, 9, 10, 60–64; value of production, 57, 58.
Limonite, 29, 30; used for metallic paint, 44.
Lincoln Spring Co., 12.
Little Falls, crushed stone, 59.
Livingston county, oil and gas, 47, 48; salt, 54.
Long Clove Trap Rock Co., 69.
Lowe Brick Co., 22.
Lynch & O'Brien, 22.
Lyon Mountain, iron ore, 30, 32–33.

McIntyre Iron Co., 34.
Madison county, clays, 17; drain tile and sewer pipe, 21; gypsum, 27; limestone, 63, 64; potteries, 23.
Magnetite, 29, 30; titaniferous, 30, 34.
Manhattan Trap Rock Co., 69.
Manlius, cement, 14.
Marble, 8, 9, 10, 64–65; value of production, 57, 58.
Medina sandstone, 46, 47, 66, 68.
Metallic paint, production, 8, 9, 10.
Millstones, 8, 9, 10, 43–44.
Mineral black, 45.
Mineral industries, value of output, 6.
Mineral paint, 44–45.
Mineral production of New York in *1904*, 8; in *1905*, 9; in *1906*, 10.
Mineral waters, 8, 9, 10.
Mineville, iron ore, 30, 31–32.
Mining developments, recent, 31–40.
Minor, J. C. jr, cited, 13.
Monarch Plaster Co., 29.
Monroe county, building brick, 18; clays, 17; drain tile and sewer pipe, 21; gypsum, 27, 29; limestone, 63, 64; potteries, 23; terra

cotta, fireproofing and building tile, 21; wall plaster, 28.
Montgomery county, limestone, 63, 64.
Monumental stone, value of output, 7, 58, 59; made from granite, 59, 60.
Mt Joy, trap, 69.
Myers, salt, 53.

Nassau county, building brick, 18; clays, 17; potteries, 23.
Natural Carbonic Gas Co., 12.
Natural cement, 7, 8, 9, 10, 13, 14.
Natural Dam Pulp Co., 70.
Natural gas, 9, 10, 46–48; value of production, 7, 48; quantity produced, 48.
New Hamburg, slate, 56.
New Lebanon, slate, 56.
New Paltz, millstones, 44.
New York city, clay deposits, 19.
New York Carbonic Acid Gas Co., 12.
Newburgh Sand-Lime Brick Co., 56.
Newland, D. H., cited, 32.
Newman, E., 47.
Niagara county, building brick, 18; clays, 17; limestone, 63, 64.
Nicholson, John, 22.
North Creek, iron ore, 36.
North Leroy, furnace flux, 63.
North River Garnet Co., 25, 26.
North Side Gas & Oil Co., 47.
Northern Iron Co., 33.
Northumberland, trap, 69.
Nyack, trap, 69.

Oakfield, gypsum, 29; wall plaster, 28.
Ocher, 45.
Old Sterling Iron Co., 30, 39.
Oliver Iron Mining Co., 31.
Oneida county, building brick, 18; clays, 17; drain tile and sewer pipe, 21; furnace flux, 63; hematite, 40, 44; limestone, 63, 64.
Onondaga Coarse Salt Association, 54.
Onondaga county, building brick, 18; cement, 13, 14; clays, 16, 17; crushed stone, 62; drain tile and sewer pipe, 21; fire brick and stove lining, 21; gypsum, 27, 28; lime, 61; limestone, 61, 63, 64; natural gas, 46, 48; paving brick, 21; potteries, 23; salt, 53, 54; terra cotta, fireproofing and building tile, 21; wall plaster, 28.
Onondaga limestone, 63.
Onondaga Pipe Line Co., 54.
Ontario, hematite, 30, 44.
Ontario Center, hematite, 41.
Ontario county, building brick, 18; clays, 17; drain tile and sewer pipe, 21; gypsum, 27; potteries, 23; terra cotta, fireproofing and building tile, 21.
Ontario Talc Co., 71.
Orange county, arsenopyrite, 10, 12; building brick, 18, 19, 20; clays, 16, 17; granite, 59; iron ore, 36; lead, 72.
Oriskany Falls, furnace flux, 63.
Orleans county, sandstone, 67, 68.
Oscawana, marble, 65.
Ossining, marble, 65.
Oswego, peat, 50.
Oswego county, natural gas, 46, 48.
Otisville, lead, 72.

Palisades, trap, 57, 69.
Palmer Bros., 22.
Paper manufacture, peat for, 49.
Paragon Plaster Co., 56.
Paterson, N. J., 72.
Pavilion Natural Gas Co., 46.
Paving blocks, 59; made from granite, 59; made from sandstone, 67; made from trap, 69.
Paving brick, manufacture, 21; value of production, 15.
Peat, 49–50.
Peekskill, emery, 24.
Petroleum, 8, 9, 10, 50–51; value of production, 7.
Pettinos Bros., 26, 27.
Phoenix Lead Co., 72.

Pierces Corners, galena, 72.
Pilgrim Paper Co., 50.
Pine pond, arsenical ore, 11.
Plaster, 27.
Plaster of paris, 27.
Pleasantville, marble, 65.
Porcelain, 24; value of production, 23.
Port Henry, furnace flux, 63; iron ore, 32, 33; titaniferous magnetite, 31.
Port Henry Iron Ore Co., 30, 31.
Port Richmond, trap, 69.
Portage beds, 46.
Portland cement, 7, 8, 9, 10, 13, 14.
Potsdam sandstone, 66.
Potter-Brown Cement Works, 14.
Pottery, 8, 9, 10, 22–23, 52; value of production, 6–7, 16, 23.
Powell & Minnock, 22.
Power & Mining Machinery Co., 59.
Presbrey, O. S., 33.
Putnam county, arsenical ore, 11; arsenopyrite, 10; granite, 59.
Putnam County Mining Corporation, 11.
Pyrite, 8, 9, 10, 52, 71.

Quarries, valuation of products reported by, 7.
Quartz, 8, 9, 10, 25, 52.
Queens county, clays, 17; terra cotta, fireproofing and building tile, 21.
Quinn, H. M., 24.
Quinroy Construction Co., 69.

Randolph, shale, 45.
Reilly & Marks, 22.
Rensselaer Brick Co., 22.
Rensselaer county, building brick, 18, 20; clays, 17; fire brick and stove lining, 21; slate, 56; terra cotta, fireproofing and building tile, 21.
Retsof Mining Co., 54.
Richmond county, building brick, 18; clays, 16, 17; fire brick and stove lining, 21; terra cotta, fireproofing and building tile, 21; trap, 57, 69.
Riprap, 59; made from granite, 59, 60; made from limestone, 60, 61; made from sandstone, 67.
Road metal, 58; made from limestone, 60, 61.
Rochester City Pottery, 23.
Rochester Composite Brick Co., 56.
Rock Glen Salt Co., 54.
Rock pond, graphite, 26, 27.
Rockland county, building brick, 18, 19, 20; clays, 16, 17; crushed stone, 62; limestone, 61, 63, 64; trap, 69.
Rockland Lake Trap Rock Co., 69.
Roofing slate, 8, 9, 10, 56.
Rosendale cement, 13.
Roseton Sand-Lime Brick Co., 56.
Rossie Iron Ore Co., 30, 37, 45.
Rossville Brick Co., 22.
Rourke, F. W. & Co., 56.
Roxbury, shale, 45.
Rubble, 59; from granite, 59, 60; from limestone, 60, 61; from sandstone, 66, 67.
Rushville Mining & Gas Co., 47.

St Josen, millstones, 44.
St Lawrence county, bluestone, 68; building brick, 18; galena, 72; hematite, 30, 37, 45; iron mines, 6; limestone, 63, 64; marble, 64; peat, 49; pyrite, 52, 71; talc, 70; titaniferous magnetite, 31; zinc, 71.
St Lawrence Pulp Co., 70.
St Lawrence Pyrite Co., 52.
Salem, slate, 56.
Salisbury mine, 6.
Salisbury Steel & Iron Co., 30.
Salt, 7, 8, 9, 10, 53–55.
Sand-lime brick, 10, 55–56.
Sandstone, 8, 9, 10, 66; value of production, 57, 58.
Sand Stone Brick Co., 56.
Saratoga county, building brick, 18; clays, 17; drain tile and sewer pipe, 21; graphite, 27; limestone, 63, 64; trap, 57, 69.
Saratoga Springs, carbon dioxide, 12.
Saratoga Trap Rock Co., 69.
Schenectady Brick Co., 56.

Schenectady county, fire brick and stove lining, 21; potteries, 23.
Schoharie county, limestone, 63, 64.
Schuyler county, salt, 54.
Scorodite, 10.
Seneca county, building brick, 18; clays, 17; drain tile and sewer pipe, 21; gypsum, 27; limestone, 63, 64; natural gas, 47.
Seneca Falls, natural gas, 47.
Sewer pipe, manufacture, 21; value of production, 16.
Shawangunk conglomerate, 66.
Shawangunk grit, 43.
Sheridan, natural gas, 47.
Shushan, slate, 56.
Sidewalk brick, 16.
Sienna, 45.
Silicate paint, 52.
Silver Creek, natural gas, 46, 47.
Silver Creek Gas and Improvement Co., 47.
Slate, 8, 9, 10, 56–57.
Smith, C. A., 22.
Smith, Edward J. & Co., 22.
Smith, G. W., 25.
Smock, John C., cited, 34; analysis of iron ore, 36–37.
Smyth, C. H. jr, cited, 39, 72.
Solvay Process Co., 53, 54, 62.
South Bay, graphite, 27.
South Dover Marble Co., 65.
South Shore Gas Co., 47.
Staley & Co., 22.
Standish, iron ore, 33.
Staples, A. S., 22.
Stella mine, 52.
Sterling Salt Co., 54.
Sterling Station, iron mines, 6, 30, 42.
Steuben county, building brick, 18; clays, 17; natural gas, 47; paving brick, 21; petroleum, 50; terra cotta, fireproofing and building tile, 21.
Stone, 57–69. *See also* Building stone; Crushed stone; Monumental stone.
Stoneware, manufacture, 23; value of production, 23.
Stove lining, manufacture, 21; value of production, 15.
Suffolk county, building brick, 18; clays, 17; potteries, 23.
Sullivan county, bluestone, 68.
Syenite, 59.
Syracuse, salt, 53; wall plaster, 28.

Tahawus Iron Ore Co., 34.
Talc, 7, 8, 9, 10, 70–71.
Talcville, 70, 71.
Tanite Co., 24.
Terra cotta, 21; value of output, 6, 16.
Ticonderoga Graphite Co., 27.
Tide Water Pipe Co., Ltd., 51.
Tile, 21; value of output, 6, 16.
Titaniferous magnetite, *see* Magnetite.
Tobin, G. L., 22.
Tompkins county, building brick, 18; clays, 17; salt, 54.
Trap, 8, 9, 10, 68–69; value of production, 57, 58.
Trenton limestone, 46, 64.
Troy, mineral paints, 45.
Tuckahoe, marble, 65.
Tusco Oil, Mineral & Gas Co., 47.

Ulster Brick Co., 22.
Ulster county, bluestone, 68; building brick, 18, 19, 20; clays, 16, 17; millstones, 43.
Union Pipe Line Co., 51.
Union Talc Co., 71.
United States Talc Co., 70.

Van der Meulen & Wylstra Art Pottery Co., 23.
Vernon beds, 45.
Vitrified paving brick, value of production, 16.
Voorheesville, natural gas, 47.

Warren county, building brick, 18; clays, 17; garnet, 25; granite, 59; graphite, 26; lime, 62; limestone 61, 63, 64.

Warsaw, salt, 53.
Washington county, building brick, 18; clays, 17; drain tile and sewer pipe, 21; feldspar, 24; fire brick and stove lining, 21; graphite, 27; lime, 62; limestone, 63, 64; ocher, 45; potteries, 23; red slate, 45; slate, 56; trap, 68.
Washington Mining Co., 72.
Watertown Sand Brick Co., 56.
Watkins, salt, 53.
Wayne county, drain tile and sewer pipe, 21; hematite, 41, 44; potteries, 23.
Welch Gas Co., 47.
Wellsville, petroleum, 51.
West Chazy, furnace flux, 63.
West Haverstraw Brick Co., 22.
West Shore Stone Co., 59.
Westchester county, building brick, 18, 20; building stone, 59; clays, 16, 17; crushed stone, 62; feldspar, 24; fire brick and stove lining, 21; granite, 59; limestone, 61, 63, 64; marble, 65; quartz, 52.
Westfield, natural gas, 47.
Wheatland, gypsum, 29; wall plaster, 28.
White Plains, marble, 65.
Whitehall, sienna, 45; slate, 56.
Whitlock, H. P., cited, 12.
William Connors Paint Manufacturing Co., 45.
Wishart, George, analyses furnished by, 11, 12.
Witherbee, Sherman & Co., 30, 31, 32.
Wolcott, hematite, 41-42.
Wood filler, 52.
Woodhull, natural gas, 47.
Wyoming county, bluestone, 67, 68; natural gas, 48; salt, 54.

Yates county, natural gas, 47.

Ziegler & Ziegler, 22.
Zinc, 71-72.

New York State Education Department

New York State Museum

JOHN M. CLARKE, Director

PUBLICATIONS

Packages will be sent prepaid except when distance or weight renders the same impracticable. On 10 or more copies of any one publication 20% discount will be given. Editions printed are only large enough to meet special claims and probable sales. When the sale copies are exhausted, the price for the few reserve copies is advanced to that charged by second-hand booksellers, in order to limit their distribution to cases of special need. Such prices are inclosed in [ ]. All publications are in paper covers, unless binding is specified.

Museum annual reports 1847–date. *All in print to* 1892, 50*c a volume,* 75*c in cloth;* 1892–*date,* 75*c, cloth.*

These reports are made up of the reports of the Director, Geologist, Paleontologist, Botanist and Entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Director's annual reports 1904–date.

These reports cover the reports of the State Geologist and of the State Paleontologist. Bound also with the museum reports of which they form a part.

Report for 1904. 138p. 20*c*. 1905. 102p. 23pl. 30*c*. 1906. 186p. 41pl. 35*c*.

Geologist's annual reports 1881–date. Rep'ts 1, 3–13, 17–date, O; 2, 14–16, Q.

In 1898 the paleontologic work of the State was made distinct from the geologic and was reported separately from 1899–1903. The two departments were reunited in 1904, and are now reported in the Director's report.

The annual reports of the original Natural History Survey, 1837–41, are out of print.

Reports 1–4, 1881–84, were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	17	$.75	21	$.40
14	.75	18	.75	22	.40
15, 2v.	2	19	.40	23	.45
16	1	20	.50	[*See* Director's annual reports]	

Paleontologist's annual reports 1899–date.

See first note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Those for 1901–3 were issued as bulletins. In 1904 combined with the Director's report.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882–date.

Reports 3–20 bound also with museum reports 40–46, 48–58 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3–4, 17 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	9	$.25	15 (En 9)	$.15
2	.30	10	.35	16 (" 10)	.25
5	.25	11	.25	18 (" 17)	.20
6	.15	12	.25	19 (" 21)	.15
7	.20	13	.10	20 (" 24)	.40
8	.25	14 (En 5)	.20	21 (" 26)	.25
				22 (" 28)	.25

Reports 2, 8–12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Botanist's annual reports 1867–date.

Bound also with museum reports 21–date of which they form a part; the first Botanist's report appeared in the 21st museum report and is numbered 21. Reports 21–24, 29, 31–41 were not published separately.

Separate reports for 1871–74, 1876, 1888–96 and 1898 (Botany 3) are out of print. Report for 1897 may be had for 40c; 1899 for 20c; 1900 for 50c. Since 1901 these reports have been issued as bulletins [*see* Bo 5–9].

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have also been published in volumes 1 and 3 of the 48th (1894) museum report and in volume 1 of the 49th (1895), 51st (1897), 52d (1898), 54th (1900), 55th (1901), 56th (1902), 57th (1903) and 58th (1904) reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged and, combined with others more recently prepared, constitute Museum memoir 4.

Museum bulletins 1887–date. O. *To advance subscribers, $2 a year or 1$ a year for division* (1) *geology, economic geology, paleontology, mineralogy; 50c each for divisions* (2) *general zoology, archeology and miscellaneous*, (3) *botany*, (4) *entomology*.

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*
G 1	48, v.1	Pa 2.3	54, v.3	En 11	54, v.3	Ar 3	52, v.1
2	51, v.1	4	" v.4	12, 13	" v.4	4	54, v.1
3	52, v.1	5,6	55, v.1	14	55, v.1	5	" v.3
4	54, v.4	7-9	56, v.2	15-18	56, v.3	6	55, v.1
5	56, v.1	10	57, v.1, pt 1	19-22	57, v.1, pt	7	56, v.4
6	57, v.1, pt 1	11-14	58, v.3			8,9	57, v.2
7-10	58, v.1	Z3	53, v.1			9	" v.2
Eg 5, 6	48, v.1	4	54, v.1			10, 11	58, v.4
7	50, v.1	5-7	" v.3	23, 24	58, v.5	Ms 1, 2	50, v.4
8	53, v.1	8	55, v.1	Bo 3	52, v.1		
9	54, v.2	9	56, v.3	4	53, v.1	*Memoir*	
10	" v.3	10	57, v.1, pt 1	5	55, v.1	2	49, v.3
11	56, v.1	11, 12	58, v.4	6	56, v.4	3, 4	53, v.2
12, 13	58, v.2	En 3	48, v.1	7	57, v.2,	5, 6	57, v.3
M 2	56, v.1	4-6	52, v.1	8	58, v:4	7	" v.4
3	57, v.1, pt 1	7-9	53, v.1	Ar 1	50, v.1		
Pa 1	54, v.1	10	54, v.2	2	51, v.1		

The figures in parenthesis in the following list indicate the bulletin's number as a New York State Museum bulletin.

Geology. **G1** (14) Kemp, J. F. Geology of Moriah and Westport Townships, Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps. Sep. 1895. 10c.

G2 (19) Merrill, F. J. H. Guide to the Study of the Geological Collections of the New York State Museum. 162p. 119pl. map. Nov. 1898. [50c]

G3 (21) Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sep. 1898. 5c.

G4 (48) Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 9pl. map. Dec. 1901. 25c.

G5 (56) Merrill, F. J. H. Description of the State Geologic Map of 1901. 42p. 2 maps, tab. Oct. 1902. 10c.

G6 (77) Cushing, H. P. Geology of the Vicinity of Little Falls, Herkimer Co. 98p. il. 15pl. 2 maps. Jan. 1905. 30c.

G7 (83) Woodworth, J. B. Pleistocene Geology of the Mooers Quadrangle. 62p. 25pl. map. June 1905. 25c.

G8 (84) —— Ancient Water Levels of the Champlain and Hudson Valleys. 206p. 11pl. 18 maps. July 1905. 45c.

G9 (95) Cushing, H. P. Geology of the Northern Adirondack Region. 188p. 15pl. 3 maps. Sep. 1905. 30c.

G10 (96) Ogilvie, I. H. Geology of the Paradox Lake Quadrangle. 54p. il. 17pl. map. Dec. 1905. 30c.

G11 (106) Fairchild, H. L. Glacial Waters in the Erie Basin. 88p. 14pl. 9 maps. Feb. 1907. 35c.

G12 (107) Woodworth, J. B.; Hartnagel, C. A.; Whitlock, H. P.; Hudson, G. H.; Clarke, J. M.; White, David; Berkey, C. P. Geological Papers. 388p. 56pl. map. May 1907. 90c., *cloth*.

Contents: Woodworth, J. B. Postglacial Faults of Eastern New York.
Hartnagel, C. A. Stratigraphic Relations of the Oneida Conglomerate.
—— Upper Siluric and Lower Devonic Formations of the Skunnemunk Mountain Region.
Whitlock, H. P. Minerals from Lyon Mountain, Clinton Co.
Hudson, G. H. On Some Pelmatozoa from the Chazy Limestone of New York.
Clarke, J. M. Some New Devonic Fossils.
—— An Interesting Style of Sand-filled Vein.
—— Eurypterus Shales of the Shawangunk Mountains in Eastern New York.
White, David. A Remarkable Fossil Tree Trunk from the Middle Devonic of New York.
Berkey, C. P. Structural and Stratigraphic Features of the Basal Gneisses of the Highlands.

Fairchild, H. L. Drumlins of New York. *In press.*

—— Later Glacial Waters in Central New York. *Prepared.*

Cushing, H. P. Geology of the Theresa Quadrangle. *In preparation.*

—— Geology of the Long Lake Quadrangle. *In press.*

Berkey, C. P. Geology of the Highlands of the Hudson. *In preparation.*

Economic geology. **Eg1** (3) Smock, J. C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*

Eg2 (7) —— First Report on the Iron Mines and Iron Ore Districts in the State of New York. 6+70p. map. June 1889. *Out of print.*

Eg3 (10) —— Building Stone in New York. 210p. map, tab. Sep. 1890. 40c.

DIVISION 2 BOTANY. Torrey, John. Flora of the State of New York; comprising full descriptions of all the indigenous and naturalized plants hitherto discovered in the State, with remarks on their economical and medical properties. 2v. il. pl. sq. Q. Albany 1843. *Out of print.*

v. 1 Flora of the State of New York. 12+484p. 72pl. 1843.

300 copies with hand-colored plates.

v. 2 Flora of the State of New York. 572p. 89pl. 1843.

300 copies with hand-colored plates.

DIVISION 3 MINERALOGY. Beck, Lewis C. Mineralogy of New York; comprising detailed descriptions of the minerals hitherto found in the State of New York, and notices of their uses in the arts and agriculture. il. pl. sq. Q. Albany 1842. *Out of print.*

v. 1 pt1 Economical Mineralogy. pt2 Descriptive Mineralogy. 24+536p. 1842.

8 plates additional to those printed as part of the text.

DIVISION 4 GEOLOGY. Mather, W. W.; Emmons, Ebenezer; Vanuxem, Lardner & Hall. James. Geology of New York. 4v. il. pl. sq. Q. Albany 1842–43. *Out of print.*

v. 1 pt1 Mather, W. W. First Geological District. 37+653p. 46pl. 1843.

v. 2 pt2 Emmons, Ebenezer. Second Geological District. 10+437p. 17pl. 1842.

v. 3 pt3 Vanuxem, Lardner. Third Geological District. 306p. 1842.

v. 4 pt4 Hall, James. Fourth Geological District. 22+683p. 19pl. map. 1843.

DIVISION 5 AGRICULTURE. Emmons, Ebenezer. Agriculture of New York; comprising an account of the classification, composition and distribution of the soils and rocks and the natural waters of the different geological formations, together with a condensed view of the meteorology and agricultural productions of the State. 5v. il. pl. sq. Q. Albany 1846–54. *Out of print.*

v. 1 Soils of the State, their Composition and Distribution. 11+371p. 21pl. 1846.

v. 2 Analysis of Soils, Plants, Cereals, etc. 8+343+46p. 42pl. 1849.

With hand-colored plates.

v. 3 Fruits, etc. 8+340p. 1851.

v. 4 Plates to accompany v. 3. 95pl. 1851.

Hand-colored.

v. 5 Insects Injurious to Agriculture. 8+272p. 50pl. 1854.

With hand-colored plates.

DIVISION 6 PALEONTOLOGY. Hall, James. Palaeontology of New York. 8v. il. pl. sq. Q. Albany 1847–94. *Bound in cloth.*

v. 1 Organic Remains of the Lower Division of the New York System. 23+338p. 99pl. 1847. *Out of print.*

v. 2 Organic Remains of Lower Middle Division of the New York System. 8+362p. 104pl. 1852. *Out of print.*

v. 3 Organic Remains of the Lower Helderberg Group and the Oriskany Sandstone. pt1, text. 12+532p. 1859. [$3.50]

——pt2. 143pl. 1861. [$2.50]

v. 4 Fossil Brachiopoda of the Upper Helderberg, Hamilton, Portage and Chemung Groups. 11+1+428p. 69pl. 1867. $2.50.

v. 5 pt1 Lamellibranchiata 1. Monomyaria of the Upper Helderberg, Hamilton and Chemung Groups. 18+268p. 45pl. 1884. $2.50.

—— —— Lamellibranchiata 2. Dimyaria of the Upper Helderberg, Hamilton, Portage and Chemung Groups. 62+293p. 51pl. 1885. $2.50.

—— pt2 Gasteropoda, Pteropoda and Cephalopoda of the Upper Helderberg, Hamilton, Portage and Chemung Groups. 2v. 1879. v. 1, text. 15+492p. v. 2, 120pl. $2.50 *for 2 v.*

—— & Simpson, George B. v. 6 Corals and Bryozoa of the Lower and U per Helderberg and Hamilton Groups. 24+298p. 67pl. 1887. $2

—— & Clarke, John M. v. 7 Trilobites and other Crustacea of the kany, Upper Helderberg, Hamilton, Portage, Chemung and Ca Groups. 64+236p. 46pl. 1888. Cont. supplement to v. 5, pt2. poda, Cephalopoda and Annelida. 42p. 18pl. 1888. $2.50.

—— & Clarke, John M. v. 8 pt1 Introduction to the Study of the Genera of the Paleozoic Brachiopoda. 16+367p. 44pl. 1892. $2.50.

—— & Clarke, John M. v. 8 pt2 Paleozoic Brachiopoda. 16+394p. 64pl. 1894. $2.50.

Catalogue of the Cabinet of Natural History of the State of New York and of the Historical and Antiquarian Collection annexed thereto. 242p. O. 1853.

Handbooks 1893–date.

In quantities, 1 cent for each 16 pages or less. Single copies postpaid as below.

New York State Museum. 52p. il. 4*c*.

Outlines history and work of the museum with list of staff 1902.

Paleontology. 12p. 2*c*.

Brief outline of State Museum work in paleontology under heads: Definition; Relation to biology; Relation to stratigraphy; History of paleontology in New York.

Guide to Excursions in the Fossiliferous Rocks of New York. 124p. 8*c*.

Itineraries of 32 trips covering nearly the entire series of Paleozoic rocks, prepared specially for the use of teachers and students desiring to acquaint themselves more intimately with the classic rocks of this State.

Entomology. 16p. 2*c*.
Economic Geology. 44p. 4*c*.
Insecticides and Fungicides. 20p. 3*c*.
Classification of New York Series of Geologic Formations. 32p. 3*c*.

Geologic maps. Merrill, F. J. H. Economic and Geologic Map of the State of New York; issued as part of Museum bulletin 15 and 48th Museum Report, v. 1. 59x67 cm. 1894. Scale 14 miles to 1 inch. 15*c*.

—— Map of the State of New York Showing the Location of Quarries of Stone Used for Building and Road Metal. Mus. bul. 17. 1897. 10*c*.

—— Map of the State of New York Showing the Distribution of the Rocks Most Useful for Road Metal. Mus. bul. 17. 1897. 5*c*.

—— Geologic Map of New York. 1901. Scale 5 miles to 1 inch. *In atlas form $3; mounted on rollers $5. Lower Hudson sheet* 60*c*.

The lower Hudson sheet, geologically colored, comprises Rockland, Orange, Dutchess, Putnam, Westchester, New York, Richmond, Kings, Queens and Nassau counties and parts of Sullivan, Ulster and Suffolk counties; also northeastern New Jersey and part of western Connecticut.

—— Map of New York Showing the Surface Configuration and Water Sheds. 1901. Scale 12 miles to 1 inch. 15*c*.

—— Map of the State of New York Showing the Location of its Economic Deposits. 1904. Scale 12 miles to 1 inch. 15*c*.

Geologic maps on the United States Geological Survey topographic base; scale 1 in. = 1 m. Those marked with an asterisk have also been published separately.

*Albany county. Mus. rep't 49, v. 2. 1898. 50*c*.
Area around Lake Placid. Mus. bul. 21. 1898.
Vicinity of Frankfort Hill [parts of Herkimer and Oneida counties]. Mus. rep't 51, v. 1. 1899.
Rockland county. State geol. rep't 18. 1899.
Amsterdam quadrangle. Mus. bul. 34. 1900.
*Parts of Albany and Rensselaer counties. Mus. bul. 42. 1901. 10*c*.
*Niagara river. Mus. bul. 45. 1901. 25*c*.
Part of Clinton county. State geol. rep't 19. 1901.
Oyster Bay and Hempstead quadrangles on Long Island. Mus. bul. 48. 1901.
Portions of Clinton and Essex counties. Mus. bul. 52. 1902.
Part of town of Northumberland, Saratoga co. State geol. rep't 21. 1903.
Union Springs, Cayuga county and vicinity. Mus. bul. 69. 1903.
*Olean quadrangle. Mus. bul. 69. 1903. 10*c*.
*Becraft Mt with 2 sheets of sections. (Scale 1 in. = ½ m.) Mus. bul. 69. 1903. 20*c*.
*Canandaigua-Naples quadrangles. Mus. bul. 63. 1904. 20*c*.
*Little Falls quadrangle. Mus. bul. 77. 1905. 15*c*.
*Watkins-Elmira quadrangles. Mus. bul. 81. 1905. 20*c*.
*Tully quadrangle. Mus. bul. 82. 1905. 10*c*.
*Salamanca quadrangle. Mus. bul. 80. 1905. 10*c*.
*Buffalo quadrangle. Mus. bul. 99. 1906. 10*c*.
*Penn Yan-Hammondsport quadrangles. Mus. bul. 101. 1906. 20*c*.

En7 (26) —— Collection, Preservation and Distribution of New York Insects. 36p. il. Ap. 1899. 5*c*.

En8 (27) —— Shade Tree Pests in New York State. 26p. il. 5pl. May 1899. 5*c*.

En9 (31) —— 15th Report of the State Entomologist 1899. 128p. June 1900. 15*c*.

En10 (36) —— 16th Report of the State Entomologist 1900. 118p. 16pl. Mar. 1901. 25*c*.

En11 (37) —— Catalogue of Some of the More Important Injurious and Beneficial Insects of New York State. 54p. il. Sep. 1900. 10*c*.

En12 (46) —— Scale Insects of Importance and a List of the Species in New York State. 94p. il. 15pl. June 1901. 25*c*.

En13 (47) Needham, J. G. & Betten, Cornelius. Aquatic Insects in the Adirondacks. 234p. il. 36pl. Sep 1901. 45*c*.

En14 (53) Felt, E. P. 17th Report of the State Entomologist 1901. 232p. il. 6pl. Aug. 1902. *Out of print.*

En15 (57) —— Elm Leaf Beetle in New York State. 46p. il. 8pl. Aug. 1902. *Out of print.*

This is a revision of En4 containing the more essential facts observed since that was prepared.

En16 (59) —— Grapevine Root Worm. 40p. 6pl. Dec. 1902. 15*c*.

See En19.

En17 (64) —— 18th Report of the State Entomologist 1902. 110p. 6pl. May 1903. 20*c*.

En18 (68) Needham, J. G. *& others.* Aquatic Insects in New York. 322p. 52pl. Aug. 1903. 80*c*, *cloth.*

En19 (72) Felt, E. P. Grapevine Root Worm. 58p. 13pl. Nov. 1903. 20*c*.

This is a revision of En16 containing the more essential facts observed since that was prepared.

En20 (74) —— & Joutel, L. H. Monograph of the Genus Saperda. 88p. 14pl. June 1904. 25*c*.

En21 (76) Felt, E. P. 19th Report of the State Entomologist 1903. 150p. 4pl. 1904. 15*c*.

En22 (79) —— Mosquitos or Culicidae of New York. 164p. il. 57pl. Oct. 1904. 40*c*.

En23 (86) Needham, J. G. *& others.* May Flies and Midges of New York. 352p. il. 37pl. June 1905. 80*c*, *cloth.*

En24 (97) Felt, E. P. 20th Report of the State Entomologist 1904. 246p. il. 19pl. Nov. 1905. 40*c*.

En25 (103) —— Gipsy and Brown Tail Moths. 44p. 10pl. July 1906. 15*c*.

En26 (104) —— 21st Report of the State Entomologist 1905. 144p. 10pl. Aug. 1906. 25*c*.

En27 (109) —— Tussock Moth and Elm Leaf Beetle. 34p. 8pl. Mar. 1907. 20*c*.

En28 (110)——22d Report of the State Entomologist 1906. *In press.*

Needham, J. G. Monograph on Stone Flies. *In preparation.*

Botany. **Bo1** (2) Peck, C. H. Contributions to the Botany of the State of New York. 66p. 2pl. May 1887. *Out of print.*

Bo2 (8) —— Boleti of the United States. 96p. Sep. 1889. [50*c*]

Bo3 (25) —— Report of the State Botanist 1898. 76p. 5pl. Oct. 1899. *Out of print.*

Bo4 (28) —— Plants of North Elba. 206p. map. June 1899. 20*c*.

Bo5 (54) —— Report of the State Botanist 1901. 58p. 7pl. Nov. 1902. 40*c*.

Bo6 (67) —— Report of the State Botanist 1902. 196p. 5pl. May 1903. 50*c*.

Bo7 (75) —— Report of the State Botanist 1903. 70p. 4pl. 1904. 40*c*.

Bo8 (94) —— Report of the State Botanist 1904. 60p. 10pl. July 1905. 40*c*.

Bo9 (105) —— Report of the State Botanist 1905. 108p. 12pl. Aug. 1906. 50*c*.

Archeology. **Ar1** (16) Beauchamp, W. M. Aboriginal Chipped Stone Implements of New York. 86p. 23pl. Oct. 1897. 25*c*.

Ar2 (18) —— Polished Stone Articles used by the New York Aborigines. 104p. 35pl. Nov. 1897. 25*c*.

Ar3 (22) —— Earthenware of the New York Aborigines. 78p. 33pl. Oct. 1898. 25*c*.

Ar4 (32) —— Aboriginal Occupation of New York. 190p. 16pl. 2 maps. Mar. 1900. 30*c*.

Ar5 (41) —— Wampum and Shell Articles used by New York Indians. 166p. 28pl. Mar. 1901. 30*c*.

Ar6 (50) —— Horn and Bone Implements of the New York Indians. 112p. 43pl. Mar. 1902. 30*c*.

Ar7 (55) —— Metallic Implements of the New York Indians. 94p. 38pl. June 1902. 25*c*.

Ar8 (73) —— Metallic Ornaments of the New York Indians. 122p. 37pl. Dec. 1903. 30*c*.

Ar9 (78) —— History of the New York Iroquois. 340p. 17pl. map. Feb. 1905. 75*c*, *cloth*.

Ar10 (87) —— Perch Lake Mounds. 84p. 12pl. Ap. 1905. 20*c*.

Ar11 (89) —— Aboriginal Use of Wood in New York. 190p. 35pl. June 1905. 35*c*.

Ar12 (108) —— Aboriginal Place Names of New York. 336p. May 1907. 40*c*.

—— Civil, Religious and Mourning Councils and Ceremonies of Adoption. *In press.*

Miscellaneous. Ms1 (52) Merrill, F. J. H. Directory of Natural History Museums in United States and Canada. 236p. Ap. 1903. 30*c*.

Ms2 (66) Ellis, Mary. Index to Publications of the New York State Natural History Survey and New York State Museum 1837–1902. 418p. June 1903. 75*c*, *cloth*.

Museum memoirs 1889–date. Q.

1 Beecher, C. E. & Clarke, J. M. Development of Some Silurian Brachiopoda. 96p. 8pl. Oct. 1889. $1.

2 Hall, James & Clarke, J. M. Paleozoic Reticulate Sponges. 350p. il. 70pl. 1898. $1, *cloth*.

3 Clarke, J. M. The Oriskany Fauna of Becraft Mountain, Columbia Co. N. Y. 128p. 9pl. Oct. 1900. 80*c*.

4 Peck, C. H. N. Y. Edible Fungi, 1895–99. 106p. 25pl. Nov. 1900. 75*c*.

This includes revised descriptions and illustrations of fungi reported in the 49th, 51st and 52d reports of the State Botanist.

5 Clarke, J. M. & Ruedemann, Rudolf. Guelph Formation and Fauna of New York State. 196p. 21pl. July 1903. $1.50, *cloth*.

6 Clarke, J. M. Naples Fauna in Western New York. 268p. 26pl. map. $2, *cloth*.

7 Ruedemann, Rudolf. Graptolites of New York. Pt 1 Graptolites of the Lower Beds. 350p. 17pl. Feb. 1905. $1.50, *cloth*.

8 Felt, E. P. Insects Affecting Park and Woodland Trees. v.1 460p. il. 48pl. Feb. 1906. $2.50, *cloth*. v.2 548p. il. 22pl. Feb. 1907. $2, *cloth*.

9 Clarke, J. M. Early Devonic of New York and Eastern North America. *In press.*

10 Eastman, C. R. The Devonic Fishes of the New York Formations. 236p. 15pl. 1907. $1.25, *cloth*.

Eaton, E. H. Birds of New York. *In preparation.*

Ruedemann, R. Graptolites of New York. Pt 2 Graptolites of the Higher Beds. *In press*

Natural history of New York. 30v. il. pl. maps. Q. Albany 1842–94.

DIVISION 1 ZOOLOGY. De Kay, James E. Zoology of New York; or, The New York Fauna; comprising detailed descriptions of all the animals hitherto observed within the State of New York with brief notices of those occasionally found near its borders, and accompanied by appropriate illustrations. 5v. il. pl. maps. sq. Q. Albany 1842–44. *Out of print.*

Historical introduction to the series by Gov. W. H. Seward. 178p.

v. 1 pt1 Mammalia. 131 + 46p. 33pl. 1842.

300 copies with hand-colored plates.

v. 2 pt2 Birds. 12 + 380p. 141pl. 1844.

Colored plates.

v. 3 pt3 Reptiles and Amphibia. 7 + 98p. pt4 Fishes. 15 + 415p. 1842.

pt3–4 bound together.

v. 4 Plates to accompany v. 3. Reptiles and Amphibia 23pl. Fishes 79pl. 1842.

300 copies with hand-colored plates.

v. 5 pt5 Mollusca. 4 + 271p. 40pl. pt6 Crustacea. 70p. 13pl. 1843–44.

Hand-colored plates; pt5–6 bound together.

lc 0 '08

DIVISION 2 BOTANY. Torrey, John. Flora of the State of New York: comprising full descriptions of all the indigenous and naturalized plants hitherto discovered in the State, with remarks on their economical and medical properties. 2v. il. pl. sq. Q. Albany 1843. *Out of print.*

v. 1 Flora of the State of New York. 12 +484p. 72pl. 1843.

300 copies with hand-colored plates.

v. 2 Flora of the State of New York. 572p. 89pl. 1843.

300 copies with hand-colored plates.

DIVISION 3 MINERALOGY. Beck, Lewis C. Mineralogy of New York; comprising detailed descriptions of the minerals hitherto found in the State of New York, and notices of their uses in the arts and agriculture. il. pl. sq. Q. Albany 1842. *Out of print.*

v. 1 pt1 Economical Mineralogy. pt2 Descriptive Mineralogy. 24 +536p. 1842.

8 plates additional to those printed as part of the text.

DIVISION 4 GEOLOGY. Mather, W. W.; Emmons, Ebenezer; Vanuxem, Lardner & Hall, James. Geology of New York. 4v. il. pl. sq. Q. Albany 1842–43. *Out of print.*

v. 1 pt1 Mather, W. W. First Geological District. 37 +653p. 46pl. 1843.

v. 2 pt2 Emmons, Ebenezer. Second Geological District. 10 +437p. 17pl. 1842.

v. 3 pt3 Vanuxem, Lardner. Third Geological District. 306p. 1842.

v. 4 pt4 Hall, James. Fourth Geological District. 22 +683p. 19pl. map. 1843.

DIVISION 5 AGRICULTURE. Emmons, Ebenezer. Agriculture of New York; comprising an account of the classification, composition and distribution of the soils and rocks and the natural waters of the different geological formations, together with a condensed view of the meteorology and agricultural productions of the State. 5v. il. pl. sq. Q. Albany 1846–54. *Out of print.*

v. 1 Soils of the State, their Composition and Distribution. 11 +371p. 21pl. 1846.

v. 2 Analysis of Soils, Plants, Cereals, etc. 8 +343 +46p. 42pl. 1849.

With hand-colored plates.

v. 3 Fruits, etc. 8 +340p. 1851.

v. 4 Plates to accompany v. 3. 95pl. 1851.

Hand-colored.

v. 5 Insects Injurious to Agriculture. 8+272p. 50pl. 1854.

With hand-colored plates.

DIVISION 6 PALEONTOLOGY. Hall, James. Palaeontology of New York. 8v. il. pl. sq. Q. Albany 1847–94. *Bound in cloth.*

v. 1 Organic Remains of the Lower Division of the New York System. 23 +338p. 99pl. 1847. *Out of print.*

v. 2 Organic Remains of Lower Middle Division of the New York System. 8 +362p. 104pl. 1852. *Out of print.*

v. 3 Organic Remains of the Lower Helderberg Group and the Oriskany Sandstone. pt1, text. 12 +532p. 1859. [*$3.50*]

——pt2. 143pl. 1861. [*$2.50*]

v. 4 Fossil Brachiopoda of the Upper Helderberg, Hamilton, Portage and Chemung Groups. 11 +1 +428p. 69pl. 1867. *$2.50.*

v. 5 pt1 Lamellibranchiata 1. Monomyaria of the Upper Helderberg, Hamilton and Chemung Groups. 18 +268p. 45pl. 1884. *$2.50.*

—— —— Lamellibranchiata 2. Dimyaria of the Upper Helderberg, Hamilton, Portage and Chemung Groups. 62 +293p. 51pl. 1885. *$2.50.*

—— pt2 Gasteropoda, Pteropoda and Cephalopoda of the Upper Helderberg, Hamilton, Portage and Chemung Groups. 2v. 1879. v. 1, text. 15 +492p. v. 2, 120pl. *$2.50 for 2 v.*

—— & Simpson, George B. v. 6 Corals and Bryozoa of the Lower and Upper Helderberg and Hamilton Groups. 24 +298p. 67pl. 1887. *$2.50.*

—— & Clarke, John M. v. 7 Trilobites and other Crustacea of the Oriskany, Upper Helderberg, Hamilton, Portage, Chemung and Catskil Groups. 64 +236p. 46pl. 1888. Cont. supplement to v. 5, pt2. Ptero oda, Cephalopoda and Annelida. 42p. 18pl. 1888. *$2.50.*

—— & Clarke, John M. v. 8 pt1 Introduction to the Study of the Genera of the Paleozoic Brachiopoda. 16+367p. 44pl. 1892. *$2.50.*

—— & Clarke, John M. v. 8 pt2 Paleozoic Brachiopoda. 16+394p. 64pl. 1894. *$2.50.*

Catalogue of the Cabinet of Natural History of the State of New York and of the Historical and Antiquarian Collection annexed thereto. 242p. O. 1853.

Handbooks 1893–date.

In quantities, 1 cent for each 16 pages or less. Single copies postpaid as below.

New York State Museum. 52p. il. *4c.*

Outlines history and work of the museum with list of staff 1902.

Paleontology. 12p. *2c.*

Brief outline of State Museum work in paleontology under heads: Definition; Relation to biology; Relation to stratigraphy; History of paleontology in New York.

Guide to Excursions in the Fossiliferous Rocks of New York. 124p. *8c.*

Itineraries of 32 trips covering nearly the entire series of Paleozoic rocks, prepared specially for the use of teachers and students desiring to acquaint themselves more intimately with the classic rocks of this State.

Entomology. 16p. *2c.*

Economic Geology. 44p. *4c.*

Insecticides and Fungicides. 20p. *3c.*

Classification of New York Series of Geologic Formations. 32p. *3c.*

Geologic maps. Merrill, F. J. H. Economic and Geologic Map of the State of New York; issued as part of Museum bulletin 15 and 48th Museum Report, v. 1. 59x67 cm. 1894. Scale 14 miles to 1 inch. *15c.*

—— Map of the State of New York Showing the Location of Quarries of Stone Used for Building and Road Metal. Mus. bul. 17. 1897. *10c.*

—— Map of the State of New York Showing the Distribution of the Rocks Most Useful for Road Metal. Mus. bul. 17. 1897. *5c.*

—— Geologic Map of New York. 1901. Scale 5 miles to 1 inch. *In atlas form $3; mounted on rollers $5. Lower Hudson sheet 60c.*

The lower Hudson sheet, geologically colored, comprises Rockland, Orange, Dutchess, Putnam, Westchester, New York, Richmond, Kings, Queens and Nassau counties, and parts of Sullivan, Ulster and Suffolk counties; also northeastern New Jersey and part of western Connecticut.

—— Map of New York Showing the Surface Configuration and Water Sheds. 1901. Scale 12 miles to 1 inch. *15c.*

—— Map of the State of New York Showing the Location of its Economic Deposits. 1904. Scale 12 miles to 1 inch. *15c.*

Geologic maps on the United States Geological Survey topographic base; scale 1 in. = 1 m. Those marked with an asterisk have also been published separately.

*Albany county. Mus. rep't 49, v. 2. 1898. *50c.*

Area around Lake Placid. Mus. bul. 21. 1898.

Vicinity of Frankfort Hill [parts of Herkimer and Oneida counties]. Mus. rep't 51, v. 1. 1899.

Rockland county. State geol. rep't 18. 1899.

Amsterdam quadrangle. Mus. bul. 34. 1900.

*Parts of Albany and Rensselaer counties. Mus. bul. 42. 1901. *10c.*

*Niagara river. Mus. bul. 45. 1901. *25c.*

Part of Clinton county. State geol. rep't 19. 1901.

Oyster Bay and Hempstead quadrangles on Long Island. Mus. bul. 48. 1901.

Portions of Clinton and Essex counties. Mus. bul. 52. 1902.

Part of town of Northumberland, Saratoga co. State geol. rep't 21. 1903.

Union Springs, Cayuga county and vicinity. Mus. bul. 69. 1903.

Olean quadrangle. Mus. bul. 69. 1903. *10c.*

Becraft Mt with 2 sheets of sections. (Scale 1 in. = ½ m.) Mus. bul. 69. 1903. *20c.*

*Canandaigua-Naples quadrangles. Mus. bul. 63. 1904. *20c.*

*Little Falls quadrangle. Mus. bul. 77. 1905. *15c.*

*Watkins-Elmira quadrangles. Mus. bul. 81. 1905. *20c.*

*Tully quadrangle. Mus. bul. 82. 1905 *10c.*

*Salamanca quadrangle. Mus. bul. 80. 1905. *10c.*

*Buffalo quadrangle. Mus. bul. 99. 1906. *10c.*

*Penn Yan-Hammondsport quadrangles. Mus. bul. 101. 1906. *20c.*

Eg4 (11) Merrill, F. J. H. Salt and Gypsum Industries of New York. 92p. 12pl. 2 maps, 11 tab. Ap. 1893. [50*c*]

Eg5 (12) Ries, Heinrich. Clay Industries of New York. 174p. 2pl. map. Mar. 1895. 30*c*.

Eg6 (15) Merrill, F. J. H. Mineral Resources of New York. 224p. 2 maps. Sep. 1895. [50*c*]

Eg7 (17) —— Road Materials and Road Building in New York. 52p. 14pl. 2 maps 34x45, 68x92 cm. Oct. 1897. 15*c*.

Eg8 (30) Orton, Edward. Petroleum and Natural Gas in New York. 136p. il. 3 maps. Nov. 1899. 15*c*.

Eg9 (35) Ries, Heinrich. Clays of New York; their Properties and Uses. 456p. 140pl. map. June 1900. $1, *cloth*.

Eg10 (44) —— Lime and Cement Industries of New York; Eckel, E. C. Chapters on the Cement Industry. 332p. 101pl. 2 maps. [illegible] 85*c*, *cloth*.

Eg11 (61) Dickinson, H. T. Quarries of Bluestone and other Sandstones in New York. 108p. 18pl. 2 maps. Mar. 1903. 35*c*.

Eg12 (85) Rafter, G. W. Hydrology of New York State. [illegible] 5 maps. May 1905. $1.50, *cloth*.

Eg13 (93) Newland, D. H. Mining and Quarry Industry of New York. 78p. July 1905. 15*c*.

Eg14 (100) McCourt, W. E. Fire Tests of Some New York Building Stones. 40p. 26pl. Feb. 1906. 15*c*.

Eg15 (102) Newland, D. H. Mining and Quarry Industry of New York. 2d Report. 162p. June 1906. 25*c*.

Eg16 (112) Mining and Quarry Industry 1906. 82p. July [illegible]

Newland, D. H. & Hartnagel, C. A. The Sandstones of New York. In *preparation*.

Mineralogy. M1 (4) Nason, F. L. Some New York Minerals and their Localities. 20p. 1pl. Aug. 1888. [10*c*]

M2 (58) Whitlock, H. P. Guide to the Mineralogic Collections of the New York State Museum. 150p. il. 39pl. 11 models. Sep. [illegible]

M3 (70) —— New York Mineral Localities. [illegible]

M4 (98) —— Contributions from the Mineralogic Laboratory. [illegible] Dec. 1905. 15*c*.

Paleontology. Pa1 (34) Cumings, E. R. Lower Siluric System of Eastern Montgomery County; Prosser, C. S. Notes on the Stratigraphy of Mohawk Valley and Saratoga County, N. Y. [illegible] May 1900. 15*c*.

Pa2 (39) Clarke, J. M.; Simpson, G. B. & Loomis, F. B. Paleontologic Papers 1. 72p. il. 16 pl. Oct. 1900. 15*c*.

Contents: Clarke, J. M. A Remarkable Occurrence of Orthoceras in the Oneonta Beds of the Chenango Valley, N. Y.
—— Paropsonema cryptophya; a Peculiar Echinoderm from the Intumescens-zone (Portage Beds) of Western New York.
—— Dictyonine Hexactinellid Sponges from the Upper Devonic of New York.
—— The Water Biscuit of Squaw Island, Canandaigua Lake, N. Y.
Simpson, G. B. Preliminary Descriptions of New Genera of Paleozoic Rugose Corals.
Loomis, F. B. Siluric Fungi from Western New York.

Pa3 (42) Ruedemann, Rudolf. Hudson River Beds near Albany and their Taxonomic Equivalents. 114p. 2 pl. map. Ap. 1901. 25*c*.

Pa4 (45) Grabau, A. W. Geology and Paleontology of Niagara Falls and Vicinity. 286p. il. 18pl. map. Ap. 1901. 65*c*; *cloth*, 90*c*.

Pa5 (49) Ruedemann, Rudolf; Clarke, J. M. & Wood, Elvira. Paleontologic Papers 2. 240p. 13pl. Dec. 1901. 40*c*.

Contents: Ruedemann, Rudolf. Trenton Conglomerate of Rysedorph Hill.
Clarke, J. M. Limestones of Central and Western New York Interbedded with Bituminous Shales of the Marcellus Stage.
Wood, Elvira. Marcellus Limestones of Lancaster, Erie Co. N. Y.
Clarke, J. M. New Agelacrinites.
—— Value of Amnigenia as an Indicator of Fresh-water Deposits during the Devonic of New York, Ireland and the Rhineland.

Pa6 (52) Clarke, J. M. Report of the State Paleontologist 1901. 280p. il. 9pl. map. 1 tab. July 1902. 40*c*.

Pa7 (63) —— Stratigraphy of Canandaigua and Naples Quadra 78p. map. June 1904. 25*c*.

Pa8 (65) —— Catalogue of Type Specimens of Paleozoic Fossils in t York State Museum. 848p. May 1903. $1.20, *cloth*.

Pa9 (69) —— Report of the State Paleontologist 1902. 464p. 52pl. 8 maps. Nov. 1903. $1, *cloth.*

Pa10 (80) —— Report of the State Paleontologist 1903. 396p. 20pl. map. Feb. 1905. 85c, *cloth.*

Pa11 (81) —— & Luther, D. D. Watkins and Elmira Quadrangles. 32p. map. Mar. 1905. 25c.

Pa12 (82) —— Geologic Map of the Tully Quadrangle. 40p. map. Ap. 1905. 20c.

Pa13 (92) Grabau, A. W. Guide to the Geology and Paleontology of the Schoharie Region. 316p. il. 24pl. map. Ap. 1906. 75c, *cloth.*

Pa14 (90) Ruedemann, Rudolf. Cephalopoda of Beekmantown and Chazy Formations of Champlain Basin. 226p. il. 38pl. Ap. 1906. 75c, *cloth.*

Pa15 (99) Luther, D. D. Geology of the Buffalo Quadrangle. 32p. map. May 1906. 20c.

Pa16 (101) —— Geology of the Penn Yan-Hammondsport Quadrangles. 28p. map. July 1906. 25c.

White, David. The Devonic Plants of New York. *In preparation.*

Hartnagel, C. A. Geology of the Rochester Quadrangle. *In press.*

Luther, D. D. Geology of the Geneva Quadrangle. *In preparation.*

—— Geology of the Ovid Quadrangle. *In preparation.*

—— Geology of the Phelps Quadrangle. *In preparation.*

Whitnall, H. O. Geology of the Morrisville Quadrangle. *Prepared.*

Hopkins, T. C. Geology of the Syracuse Quadrangle. *In preparation.*

Hudson, G. H. Geology of Valcour Island. *In preparation.*

Zoology. **Z1** (1) Marshall, W. B. Preliminary List of New York Unionidae. 20p. Mar. 1892. 5c.

Z2 (9) —— Beaks of Unionidae Inhabiting the Vicinity of Albany, N. Y. 24p. 1pl. Aug. 1890. 10c.

Z3 (29) Miller, G. S. jr. Preliminary List of New York Mammals. 124p. Oct. 1899. 15c.

Z4 (33) Farr, M. S. Check List of New York Birds. 224p. Ap. 1900. 25c.

Z5 (38) Miller, G. S. jr. Key to the Land Mammals of Northeastern North America. 106p. Oct. 1900. 15c.

Z6 (40) Simpson, G. B. Anatomy and Physiology of Polygyra albolabris and Limax maximus and Embryology of Limax maximus. 82p. 28pl. Oct. 1901. 25c.

Z7 (43) Kellogg, J. L. Clam and Scallop Industries of New York. 36p. 2pl. map. Ap. 1901. 10c.

Z8 (51) Eckel, E. C. & Paulmier, F. C. Catalogue of Reptiles and Batrachians of New York. 64p. il. 1pl. Ap. 1902. 15c.

Eckel, E. C. Serpents of Northeastern United States.
Paulmier, F. C. Lizards, Tortoises and Batrachians of New York.

Z9 (60) Bean, T. H. Catalogue of the Fishes of New York. 784p. Feb. 1903. $1, *cloth.*

Z10 (71) Kellogg, J. L. Feeding Habits and Growth of Venus mercenaria. 30p. 4pl. Sep. 1903. 10c.

Z11 (88) Letson, Elizabeth J. Check List of the Mollusca of New York. 114p. May 1905. 20c.

Z12 (91) Paulmier, F. C. Higher Crustacea of New York City. 78p. il. June 1905. 20c.

Entomology. **En 1** (5) Lintner, J. A. White Grub of the May Beetle. 32p. il. Nov. 1888. 10c.

En2 (6) —— Cut-worms. 36p. il. Nov. 1888. 10c.

En3 (13) —— San José Scale and Some Destructive Insects of New York State. 54p. 7pl. Ap. 1895. 15c.

En4 (20) Felt, E. P. Elm-leaf Beetle in New York State. 46p. il. 5pl. June 1898. 5c.

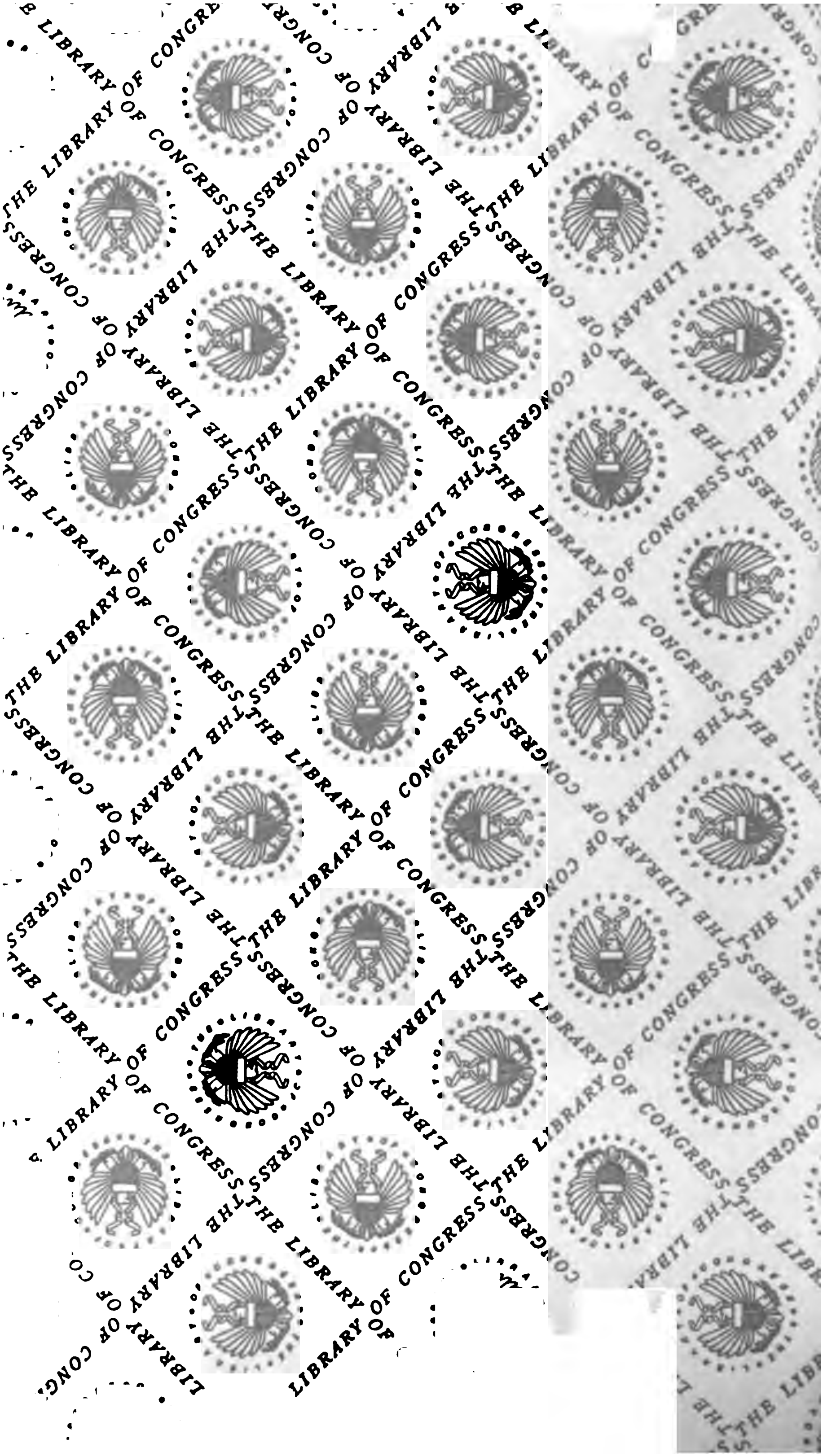
See En15.

En5 (23) —— 14th Report of the State Entomologist 1898. 150p. il. 9pl. Dec. 1898. 20c.

En6 (24) —— Memorial of the Life and Entomologic Work of J. A. Lintner Ph.D. State Entomologist 1874–98; Index to Entomologist's Reports 1–13. 316p. 1pl. Oct. 1899. 35c.

Supplement to 14th report of the State Entomologist.

H 137 83



THE LIBRARY OF CONGRESS

FEB 83
N. MANCHESTER,
INDIANA 46962

LIBRARY OF CONGRESS
0 003 306 870 0